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SUGARBEET RESEARCH

1982 REPORT

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FOREWORD

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The report presents results of investigations strengthened by contributions received under Cooperative Agreements between Agricultural Research Service, U.S. Department of Agriculture, and the Beet Sugar Development Foundation; the California Beet Growers Association, Ltd.; the Farmers and Manufacturers Beet Sugar Association; and the Sugarbeet Research and Education Board of Minnesota and North Dakota.

Trade names occur in this report solely to provide specific information and do not signify endorsement by the U.S. Department of Agriculture or the Beet Sugar Development Foundation.

CONTENTS

		Page
SECTION A	SALINAS, CALIFORNIA	
	Abstracts of Papers.	A2
	Interspecific Hybridization.	A8
	Development of Breeding Lines.	A15
SECTION B	LOGAN, UTAH	
	Experimental Field Trials.	B2
	Selection of 60-day Old Beets Based on Root/top Ratio and Root Weight	B6
	Physiological Section	B7
	Growth Analysis.	B18
	Insect Studies	B23
	Disease Studies.	B31
	Potential Alcohol Fuel Research.	B34
	Physiology-Biochemistry.	B66
SECTION C	FORT COLLINS, COLORADO	
	Abstracts of Papers.	C3
	Rapid Selection and Regeneration of Elite Sugarbeet Genotypes.	C6
	Rhizoctonia Root Rot Research and Resistance Breeding	C7
	Cercospora Leaf Spot Research and Breeding For Cercospora/Curly Top Resistance. . . .	C23
	Sugarbeet Quality Improvement Research: Genetics, Physiology and Methods	C30
	Clarification of Sugarbeet Extracts. . . .	C35
	Other Research of Interest to BSDF Members	C36
SECTION D	FARGO, NORTH DAKOTA	
	Root Inhabiting Bacteria	D2
	Sugarbeet Breeding	D4
	Measuring Internal CO_2 Under Field Conditions	D6
	Identification of Low and High Internal CO_2 Genotypes Under Field and Laboratory Conditions	D8
	Response of Sugarbeets to Multiple Pesticides	D12

CONTENTS

		PAGE
SECTION D	FARGO, NORTH DAKOTA (cont.)	
	Effect of Freezing on Sugarbeet Storage Losses	D14
SECTION E	EAST LANSING, MICHIGAN AND BELTSVILLE, MARYLAND	
	Main Accomplishments At East Lansing during 1982.	E2
	Publications	E3
	Hybrids	E5
	Present Application of Shoot Culture in East Lansing Breeding Program.	E9
	Tests of Fungicides to Control <u>Cercospora</u> Leaf Spot and <u>Rhizoctonia</u> Crown Rot Diseases of Sugarbeet.	E10
	Breeding Sugarbeets for Resistance to Black Root and Leaf Spot	E13

SUGARBEET RESEARCH

1982 Report

Section A

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CONTENTS

Page

ABSTRACTS OF PAPERS

Published or in press A2
Published since 1981. . . . . A7

INTERSPECIFIC HYBRIDIZATION

An Analysis of Resistance To Cyst Nematode in Sugarbeet by M. H. Yu A8

Inheritance of Nematode Resistance and Hypocotyl Color From Derivatives of a Resistant Sugarbeet Line by M. H. Yu. A10

Vulgaris-_procumbens_ Hybrids by Helen Savitsky A13

DEVELOPMENT OF BREEDING LINES AND GERMPLASM by R. T. Lewellen and I. O. Skoyen

Summary of Accomplishments, 1982. . . . . A15

Variety Trials, Salinas A21

Genetic Improvement in Sugar Yield. A33

Performance of 755 Populations. A34

S_1 Family Recurrent Selection A39

Effects of Mass Selection on GCA. A42

Powdery Mildew Evaluation, 1982 . . . . A44

Virus Yellows (BWYV) Evaluation, 1982 . . . . A46

Variety Trials, Brawley A52

Fodder Beet Variety Trial, Brawley. A61

University of California, Davis, Trial. A62

Company Tests of USDA Varieties A63

Erwinia and Powdery Mildew Evaluation A66

Virus Yellows (BYV-BSYV) Evaluation, 1981 . . . . . . A68

Powdery Mildew Evaluation, 1981 . . . . A80

Selection for Root Toughness. A84

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION, 1982

DUFFUS, JAMES E. Bemisia tabaci transmission of a new virus of the yellowing type from southwestern U.S.A. Proc. 4th Conf. of ISHS Working Group on Vegetable Viruses, pg. 59. 1982.

Extremely large populations of whiteflies occurred during the summer and fall of 1981 inducing a series of epidemics of virus-like diseases of many crops in the desert production areas of California and Arizona. Insect transmission studies indicate that Bemisia tabaci transmitted at least three major disease inducing agents in the disease complex. Each of the major types of whitefly transmitted diseases, squash leaf curl (infectious variegation), cotton leaf crumple (leaf curl) and lettuce infectious yellows (LIYV)(yellowing) were represented. LIYV caused losses of 50-75% in lettuce crops and severely reduced sugarbeet yields. Virus particles are rod-shaped (11 x 1000-2000 nm) and appear similar to the particles of beet pseudo yellows virus, the first member of this group.

DUFFUS, JAMES E. The luteoviruses--Old viruses, new roles. Proc. IV Intern. Conf. of Comparative Virology, pg. 208. 1982.

Mixed infections of plant viruses in nature are probably more common than infections by single viruses. Recent evidence indicates the association of beet western yellows virus (BWYV) with the potato leaf roll syndrome. Distinct serotypes of BWYV or potato leaf roll distinguished by various serological techniques have been isolated from individual potatoes from various parts of the world. A similar situation exists with the subterranean clover red leaf (SCRL) disease of legumes and sugarbeet in Australasia. Disease complexes of BWYV and SCRLV in pea, subterranean clover and sugarbeet occur in nature. Under natural conditions most plant viruses in mixed infections are probably transmitted independently. Interactions between viruses in the same plants have been little studied but may affect severity, epidemiology and the properties of the progeny virions. The interrelationships of viruses in regard to vector specificity, host range, and economic impact is an area that research has somewhat by-passed but the properties exhibited by virus complexes reinforce the importance of using vectors and other biological factors in the continuing study of plant viruses.

DUFFUS, JAMES E. A new yellowing virus threat to desert sugarbeets--transmitted by the whitefly, Bemisia tabaci. California Sugar Beet. pp. 31-32. 1982.

Extremely large populations of whiteflies (Bemisia tabaci) occurred during the summer and fall of 1981 inducing a series of epidemics of virus diseases on many of the important crops in the desert production areas of California and Arizona. Sugarbeets, infected early in their growth cycle, experienced serious losses estimated to be in the range of 20-30%. Unless adequate controls are found, this disease could seriously affect sugarbeet production in the desert regions.

DUFFUS, JAMES E. and R. A. FLOCK. Whitefly-transmitted disease complex of the desert southwest. California Agric. 36:4-6. 1982.

Whitefly populations virtually exploded in the desert southwest during 1981-82. These high populations of whiteflies transmitted a complex of disease-causing entities to many of the major crops of the area causing losses estimated in the range of $100,000,000. Basic vector and host range studies of the entities transmitted by the whiteflies clearly distinguishes the diseases, clears up some misconceptions concerning epidemiology and suggests possible control measures.

DUFFUS, JAMES E., D. E. MAYHEW, and R. A. FLOCK. Lettuce infectious yellows--A new whitefly transmitted virus of the desert southwest. Phytopathology 72:963. 1982.

A new infectious yellowing disease of lettuce, sugarbeet, carrot, and other crop and weed hosts has been found in the desert areas of southwestern U.S.A. The causal virus, (lettuce infectious yellows [LIYV]) transmitted by the whitefly, Bemisia tabaci, caused losses of from 50 to 75% in lettuce production in desert growing areas during the 1981-1982 growing season. The virus particles as visualized from leaf dips of field plants, whitefly induced infections in the greenhouse, and partially purified preparations are rod-shaped (11 x 1000-2000 nm). The host range, particle size and properties of LIYV appear to be distinct from previously described whitefly transmitted viruses.

HANDLEY, M. K., JAMES E. DUFFUS, and R. J. SHEPHERD. Figwort mosaic virus: A new caulimovirus. Phytopathology 72:952. 1982.

Figwort mosaic virus (FMV), isolated from naturally infected Scrophularia californica Cham. (figwort), is transmitted by aphids and has inclusion bodies characteristic of the caulimovirus group. We have established that the virus has a circular double stranded DNA genome of about 8000 base pairs. Clones (in E. coli plasmid pBR322) of two strains of the virus and of a naturally occurring, non-infectious deletion have been compared by restriction endonuclease mapping. A physical map of the native virus has been prepared by determining the locations of the single stranded discontinuities with respect to the locations of several restriction sites. Four discontinuities occur in the viral DNA; three of these occur in one strand, and one occurs in the other strand. These clones of FMV show little or no sequence homology with cauliflower mosaic virus in Southern blot hybridizations.

LEWELLEN, R. T., I. O. SKOYEN, E. D. WHITNEY, and J. S. McFARLANE. Registration of 11 sugarbeet germplasm lines with resistance to virus yellows. Crop Sci. 22:900-901. 1982.

Descriptions of 11 germplasm lines that were released between 1978 and 1981 were submitted for registration in CROP SCIENCE. These lines should be useful to commercial breeders as sources of multiple disease resistance. Resistance to virus yellows, beet mosaic virus, curly top, Erwinia root rot, powdery mildew, and bolting are included in these lines.

LIU, H. Y. and JAMES E. DUFFUS. The differentiation of distinct serotypes from potato leafroll affected plants by enzyme-linked immunosorbent assay (ELISA). Amer. Potato J. (In press). 1982.

Evidence is accumulating which indicates the association of beet western yellows virus (BWYV) with the potato leaf roll syndrome throughout the world. Distinct serotypes of BWYV and/or potato leaf roll have been distinguished by various serological techniques. At least three major groups of antisera have been produced, which express very high specificity by the enzyme-linked immunosorbent assay (ELISA) technique. There is no cross reaction between the groups which indicates that at least two different serotype antisera must be used to distinguish the possible leaf roll inducing entities in potato.

STEELE, A. E. Effects of selected nematicides on hatching of Heterodera schachtii. J. Nematol. (In press). 1983.

This paper reports a study of the initial and residual effects of the insecticide-nematicides aldicarb, carbofuran, fensulfothion and fenamiphos on hatching and emergence of larvae from cysts of the sugarbeet nematode, *Heterodera schachtii*. Although concentrations of aldicarb or carbofuran above 1 µg/ml initially suppressed hatching, removal of the nematicides resulted in hatch stimulation. These results suggest that reported failures of aldicarb to give consistent control of *H. schachtii* may result from increased hatching of nematode eggs exposed to low concentrations of the chemical and calls attention to the need for careful application of effective doses of nematicides.

STEELE, A. E., H. TOXOPEUS, and W. Heijbroek. A comparison of the hatching of juveniles from cysts of Heterodera schachtii and H. trifolii. J. Nematol. 14:588-592. 1982.

The effects of root diffusates of selected plants within the families Chenopodiaceae and Cruciferae and the hatching agent zinc chloride were tested for their effects on hatching and emergence of juveniles from cysts of *Heterodera schachtii* and a race of *H. trifolii* parasitic on Chenopodaceae and Cruciferae in The Netherlands. Although all diffusates strongly stimulated hatching of juveniles of *H. schachtii*, their effects on *H. trifolii* were less evident.

STEELE, A. E., H. TOXOPEUS, and W. HEIJBROEK. Susceptibility of plant selections to Heterodera schachtii and a race of H. trifolii parastic on sugarbeet in The Netherlands. J. Nematol. (In press). 1983.

This paper reports investigations of the host-ranges of the sugarbeet nematode, *Heterodera schachtii*, and a race of the clover cyst nematode, *H. trifolii* parasitic on sugarbeet in The Netherlands. In addition to providing information on susceptible and non-susceptible crop plants, the study revealed that interspecific hybrids of *Beta* resistant to *H. schachtii* were highly susceptible to *H. trifolii*. An accession of *B. maritima* was highly resistant to *H. trifolii*. Since *B. maritima* crosses readily with *B. vulgaris*, this resistance may be incorporated into sugarbeet with little difficulty.

WHITNEY, E. D. Cultivar by isolate interactions between sugarbeet and Erwinia carotovora betavasculorum. Phytopathology 72:1003. 1982.

Both quantitative and qualitative host resistance to E. carotovora betavasculorum, the incitant of bacterial vascular necrosis and rot of sugarbeet, has been shown. Early studies of isolates inoculated onto United States cultivars suggested that those tested reacted similarly to the pathogen but that aggressiveness differed among the isolates. However, when European cultivars were included in tests with nine isolates of the pathogen, a cultivar by isolate interaction was observed. Thus, biotypes or races of the pathogen were differentiated by the host reaction. This differential reaction between United States and European cultivars suggests additional factors for resistance and divergence between European and United States cultivars.

WHITNEY, E. D., R. T. LEWELLEN, and I. O. SKOYEN. Reaction of sugarbeet to powdery mildew: Genetic variation, association among testing procedures and results of resistance breeding. Phytopathology 73:182-185. 1983.

Powdery mildew of sugarbeet is a serious disease in the western U.S. and is controlled by fungicides. These studies provide evidence that high associations exist between the disease level of greenhouse inoculated plants and naturally infected sugarbeet grown under field conditions. This work also shows that mildew resistance is a heritable trait and can be selected for under defined greenhouse conditions of cool temperatures and moderate humidity. This work should lead to the development of resistant varieties and reduce the use of fungicides.

WHITNEY, E. D. and I. O. SKOYEN. Control of Rhizoctonia root rot of sugarbeet by fumigation with Terraclor. Fungic. Nematic. Tests. (In press). 1982.

Sugarbeet seed was planted in a sandy loam soil, Chualar series, on May 19 and stands thinned on June 26. Terraclor 25 EC was applied through a solid set sprinkler irrigation system on August 2, August 30, and September 28 at the rate of 2.8 or 5.6 kg/h ai to plots 9 m by 12 m. Within each plot two 12 m long sub-plots were randomly selected for inoculated and noninoculated treatments. Each treatment had three replications. Inoculum of R. solani, on dried barley grain, was applied mechanically along the plant rows and into the leaf whorls on August 4 and 23. Plots were sprinkler irrigated as needed. At harvest on November 3, each beet was cut and root rot estimated on a scale of 0, 7, 25, 50, 75, 93, and 100%. A disease index was calculated. Disease incidence was moderate in inoculated plots and nil in the controls. No phytotoxic effects were observed.

YU, M. H. Inheritance of resistance to Heterodera schachtii and chromosome segregation in triploid sugar beets. Can. J. Genet. Cytol. 24:567-574. 1982.

Reciprocal crosses of autotriploid nematode (Heterodera schachtii Schm.) resistant sugar beet (Beta vulgaris L.) 6122 and diploid susceptible plants resulted in low seed set and germination. Chromosome numbers of the progeny of 6122 ranged from 18 to 38, with the majority of the progeny in 18 and 19 chromosome classes. Inheritance of nematode resistance through 6122 as

female parent was 24.8% and that of the reciprocal was lower. Plant 6122 probably bears only one dose of the resistance factor(s). The resistance has little effect on the survival of aneuploid gametes. The original triploid zygote could have developed from a first division restitution diploid megaspore bearing nematode resistance fertilized by a haploid gamate. At pachytene, trivalent associations of 6122 were not intact, with the occurrence of intercalary and terminal desynapses, heteromorphic pairings, and inversion loops. On an average 7.24 III, 7.71 III, and 0.09 III were observed at metaphase I in microsporocytes of 6122, the autotriploid control, and triploid interspecific 4x B. vulgaris x 2x B. procumbens Chr. Sm. F_1 hybrids, respectively. Meiotic irregularities occurred in over 19% of 6122 cells at AI. At TII up to six micronuclei, two AII bridges, carry-over AI bridges, and single and double restitution nuclei occurred.

YU, M. H. Interpretation of mechanism for nematode resistance in sugarbeet. J. Am. Soc. Sugar Beet Technol. 21: (In press). 1982.

The resistance to Heterodera schachtii Schm. in sugarbeet, Beta vulgaris L., that was introgressed from B. procumbens Chr. Sm. conditions high resistance, not immunity. A hypersensitive reaction of the resistant sugarbeet cells not only causes the death of nematode larvae but also hampers certain normal vascular functions of the host-plants. Germininating seedlings of the resistant sugarbeets are more sensitive to the multiple nematode infections than the larger plants. The mechanism of resistance to H. schachtii in sugarbeet was determined to be antibiosis. Antibiosis is expressed as resistance to the survival and reproduction of H. schachtii.

YU, M. H. Interactions between curly leaf and dwarf mutants in tomato. Genetics 100:s77. 1982.

A recessive mutant factor that conditions the dwarf, curly leaf characteristic of tomato was isolated from a wild Lycopersicon accession. When this mutant was crossed to the d^{cr} dwarf mutant all F_1 progenies were normal, i.e., wild type. This suggests these two mutants are non-allelic, and that they are complementary genes because they yield a non-parental phenotype. The 342 F_2 progenies contained three groups of plants, viz., 255 curly leaf, 66 normal, and 21 d^{cr} dwarf. Germination in these families was 76%. This segregation ratio was approximately 12:3:1, and there were no obvious intermediate plant types. These results indicate that some type of epistatic effect or multiple-factor inheritance is involved in the production of these plant characteristics.

YU, M. H. The dwarf curly leaf tomato mutant. J. Hered. 73:470-472. 1982.

A dwarf tomato plant with short thick hypocotyl, curled cotyledons, and dense curly leaves was discovered in 1977 among seedlings of Lycopersicon pimpinellifolium accession LA 1610 collected at Asia-El Pinõn, Lima, Perú. Leaves of mutant plants usually curl tightly, forming a mass not more than 2.5 cm in either dimension and cannot be opened without breaking. This mutant is highly infecund. Inheritance studies showed the dwarf curly leaf trait to be controlled by a recessive Mendelian gene. The symbol cu-3 is proposed to denote the allele of this plant characteristic. This mutant does not respond to the application of gibberellic acid and tetraethyl pyrophosphate. Crosses between the cu-3 mutant and the d^{cr} mutant produced normal plants.

PAPERS WHICH HAVE BEEN PUBLISHED SINCE BEING ABSTRACTED IN PREVIOUS SUGARBEET RESEARCH REPORTS

DUFFUS, J. E. and G. R. JOHNSTONE. Beet pseudo-yellows virus in Tasmania - The first report of a whitefly transmitted virus in Australasia. Australasian Plant Pathology 10:68-69. 1981.

DUFFUS, J. E. and G. R. JOHNSTONE. The probable long association of beet western yellows virus with the potato leaf roll syndrome in Tasmania. Aust. J. Exp. Agric. Anim. Husb. 22:353-356. 1982.

DUFFUS, J. E., G. M. MILBRATH, and R. PERRY. Unique type of curly top virus and its relationship with horseradish brittle root. Plt. Dis. 66: 650-652. 1982.

JOHNSTONE, G. R., J. E. DUFFUS, D. MUNRO, and J. W. ASHBY. Purification of a Tasmanian isolate of subterranean clover red leaf virus, and its serological interactions with a New Zealand isolate and other luteoviruses. Aust. J. Agric. Res. 33:697-703. 1982.

LEWELLEN, R. T. Sugarbeet Diseases. Pages 280-281 in Parker, S. P. (Ed.), McGraw-Hill Encyclopedia of Science and Technology, 5th Edition, McGraw-Hill, N.Y. 1982.

McFARLANE, J. S. Registration of two sugarbeet parental lines. Crop Sci. 22:454. 1982.

McFARLANE, J. S., I. O. SKOYEN, and R. T. LEWELLEN. Registration of four sugarbeet germplasm lines. Crop Sci. 22:698. 1982.

WHITNEY, E. D. The susceptibility of fodder beet and wild species of Beta to an Erwinia sp. from sugarbeet. Plt. Dis. 65:664-665. 1982.

INTERSPECIFIC HYBRIDIZATION

An Analysis of Resistance to Cyst Nematode in Sugarbeet

M. H. Yu

Sugarbeet, Beta vulgaris L., is the principal host for the sugarbeet cyst nematode, Heterodera schachtii Schm. In contrast, cyst nematode is the most important nematode of sugarbeet and is an important pest on numerous other plants, including 218 species within 95 genera. This nematode is responsible for major sugarbeet yield reductions in many parts of the world. Losses due to this nematode range from partial decreases in production to total failure of a crop.

Resistance to the cyst nematode is lacking in the primary gene pool of sugarbeet, and is one of the most sought traits to be incorporated in sugarbeet. Through interspecific hybridization and the subsequent selections and crosses, this resistance has been introgressed from a wild beet species B. procumbens Chr. Sm. into the genome of sugarbeet. It has been confirmed, both from the greenhouse and laboratory observations, that resistance in the nematode-resistant genotypes is not due to failure of nematode juveniles to enter sugarbeet roots but is due to failure of the large majority of larvae to complete their life cycle in the roots.

Reaction of the resistant sugarbeets to the invasion of cyst nematodes seemed to be different under field and greenhouse conditions. When the selected nematode-resistant greenhouse-grown sugarbeets were transplanted to nematode infested field plots, these plants generally grew well, producing stubby tap roots with sprangled secondaries. However, when seeded into heavily nematode infested soil, the greenhouse selected resistant sugarbeet lines also were partially stunted and their yields reduced. It should be mentioned that sugarbeets are particularly sensitive to nematode infection at the seedling stage. This appears to apply to both the resistant and susceptible sugarbeets. The quantitative relationships between preplanting population densities of sugarbeet nematode and sugarbeet yields are primarily a function of soil temperature. Heterodera schachtii is most pathogenic on sugarbeet grown at soil temperatures of 21-27° C and less pathogenic on sugarbeet grown at soil temperature below 10° C or above 31° C.

It is conceived that the hypersensitive host reaction induced by nematodes in radicles of the young resistant sugarbeet seedlings may cause a rapid syncytial necrosis in the infected roots, which severely affects the normal vascular functions of the sugarbeets. In contrast, in susceptible sugarbeets the infected cells usually do not become necrotic until after nematodes complete their life cycle. Hypersensitive reaction that is characterized by a rapid necrosis of infected tissue together with inactivation of the attacking agent is considered a defensive mechanism of the host-plant against potential parasites. In general, the severity to the host caused by hypersensitivity would depend upon the number of nematode juveniles invading the root, and the length of time larvae remain alive and feed. The few adult female nematodes, provided they finally develop to maturity in resistant plants, sometimes form rather small cysts. They probably also contain fewer viable eggs.

The fundamentals of nematode resistance in the resistant sugarbeet are very much of concern. Resistance to sugarbeet nematode is a dominant factor(s) that causes a high mortality of nematode juveniles feeding on the resistant sugarbeet hosts. One possible explanation to the larvicidal activity is the presence of a toxic compound in syncytial areas of the roots. Based on biochemical analyses both the XAD-2-retained and nonretained fractions of MeOH extracts of the resistant sugarbeets manifest activity in reducing nematode larval migration through the Kimwipe barrier compared to the nontreated controls. The preliminary results from such assay also suggest that there may be two or more active compounds in the extract and that this activity cannot be exclusively distinguished as the result of the presence of aromatic or nonaromatic compounds. In general, nematicidal activity of the extracts and fractions is low and variable. Resistance in the resistant sugarbeet lines may in fact be due to the presence of a phytoalexin, a substance that would only be formed subsequent to the infection of sugarbeet cyst nematodes.

Host-plant responses to the parasite infection have a wide range of variations. Classification of resistant phenomena may be expressed by the fate of parasites feeding on the host-plant or by the degree of host-plant damage resulting from infection. Presently the criteria of resistance classification in the field of nematology have yet to be established. The standards used in entomological literature are, therefore, tentatively adopted here to describe the phenomenon of resistance to H. schachtii in sugarbeet. The intensities of host resistance are practically classified into five categories, namely, immunity, high resistance, low resistance, susceptibility, and high susceptibility. An immune plant is a nonhost for a given parasite; the parasite will never consume or injure the plant under any known conditions. A highly susceptible plant, on the other hand, suffers more than average damage from a specific parasite. According to these standards the resistance to cyst nematode in the resistant sugarbeet can only be classified as a high resistance, not immunity.

Classification of host-plant resistance based on the causative factor is a better criterion for both basic and applied research. The three fundamental mechanisms of host-plant resistance that have gained wide acceptance and popularity not only because of their simplicity and generality but also because of their accuracy in describing parasite and plant responses are: 1) Antixenosis, or nonpreference. The plant is a poor or an undesirable host; it is avoided by the parasite for food, oviposition, or shelter. 2) Antibiosis. The plant used for food exerts adverse effects on the parasite such as reduced fecundity, decreased size, subnormal length of life, or increased mortality. 3) Tolerance. An adaptive mechanism of a host-plant to withstand infection and to support parasite populations that would otherwise severely damage susceptible plants. These three categories of resistance are nonexclusive. They may interact, complement, or compensate each other in intensifying resistance expression. Among these mechanisms antibiosis and antixenosis exert selection pressure on the parasite, but tolerance does not.

The high mortality of nematode juveniles, subnormal length of life, smaller cyst size, and reduced fecundity suggest that the resistance mechanism involved here is antibiosis. In other words, the host-plant resistance found in the resistant sugarbeet that was introgressed from *B. procumbens* is resistance to survival and reproduction of *H. schachtii*. This nematode resistance is not antixenosis because nematodes do enter and feed on the resistant sugarbeet plants and use them for food. Nor is it tolerance, since the invading nematodes encounter severe adverse effects exerted by the resistant sugarbeet host. Among the three mechanisms, antibiosis provides the most effective resistance. The effectiveness of antixenosis tends to be reduced when it is used in monoculture. On the other hand, a host-plant of tolerance usually supports parasite populations.

Inheritance of Nematode Resistance and Hypocotyl Color from Derivatives of a Resistant Sugarbeet Line

M. H. Yu

The diploid (2n = 18) sugarbeet selection 3584, homozygous for nematode resistance, was a self-compatible, multigerm, green hypocotyl (a trait recessive to red hypocotyl) plant derived from a hybrid between the annual, self-fertile C5600 and a diploid, biennial, self-sterile sugarbeet plant heterozygous for nematode resistance. All the 3584 out-crossed and test-crossed progeny, thus far examined, carried nematode resistance, presumably in heterozygous condition.

In the current study, most of the plants were screened for nematode resistance twice and some three times. When these nematode-resistant heterozygotes were self-pollinated they gave resistance to 48.8% of progeny (Table 1). The rates of resistance transmission ranged from 31 to 60%, which was essentially not different from the 28 to 59% observed in previous studies.

When the heterozygous resistant 3584 progeny plants were used as pollinators and crossed with genetic male-sterile plants of 0755 and with self-incompatible F80-37 sugarbeets, 23.8% of the progeny were resistant (Table 2). Progeny derived from the reciprocally crossed heterozygous 3584 progenies had 42.4% with the resistance (Table 3). A higher frequency of resistant progeny from the latter reciprocally crossed parents was expected, since the genotype of all 3584 derivatives was self-compatible. A larger proportion of red hypocotyl progeny in this group compared to that of the corresponding F80-37 crosses indicates the occurrence of self-fertilization. The ratio of red (300) to green (162) plants from these red 3584 derivative parents was 1.9 (Table 3), in comparison to that of 1.2 from its corresponding F80-37 crosses (Table 2) and 2.9 from selfed red 3584 progeny plants (Table 1). These results suggest that line 3584 has a high self-compatibility.

The possibility of linkage between factors conditioning nematode resistance and plant color seems to be remote, if at all. Resistance was originally bearing in the genome of sugarbeet with green hypocotyl, i.e., 3584. However, none of the three green hypocotyl progeny groups resulting from those 3584 and its offspring crosses inherited a higher rate of nematode

resistance than the red hypocotyl groups. The frequencies of resistant progenies in red and in green derived from these groups of resistant heterozygotes were, respectively, 47.9% and 34.0% from self-pollination (Table 1), 25.6% and 21.9% from pollen transmission (Table 2), and 43.7% and 42.6% from the reciprocally crossed heterozygous 3584 resistant parents (Table 3). If there was a significant linkage relationship between the loci for plant color and nematode resistance, frequencies of nematode resistance in the green plants should be at least no lower than that in the groups with red hypocotyl.

Table 1. Transmission of nematode resistance and hypocotyl color through self-pollination of heterozygous nematode-resistant sugarbeets derived from various crosses in line 3584.

Source of Selfed Plants1/	Number of Seedlings2/			Hypocotyl Color3/			
				Red		Green	
	Total	NR	NS	NR	NS	NR	NS
C17/3584	104	62	42				
730/DDR	31	15	16	11	13	4	3
731-056	14	6	8				
755-130	27	14	13				
758/DDR	19	11	8	10	5	1	3
759-043	24	14	10				
765/DDR	29	9	20	9	15	0	5
765-238	23	13	10				
770/DDR	47	22	25	18	15	4	10
770-086R	41	15	26	11	19	4	7
771/DDR	27	14	13	10	8	4	5
771 O.P.	18	7	11				
776 Red	76	35	41	(31)		(4)	
783 Erect	94	43	51				
Total	574	280	294	69	75	17	33

1/ Code numbers are designations for individual nematode-resistant progeny plants derived from selection 3584. DDR is Detroit Dark Red garden beet, used as pollinator.

2/ NR is nematode-resistant; NS is nematode-susceptible.

3/ Nonsegregating green plants and seedlings from red plants in which color trait had not been classified are not listed. Figures in parentheses are not included in the total.

Table 2. Pollen transmission of nematode resistance and hypocotyl color from resistant heterozygotes of 3584 derivatives.

Male Parents[1/]	Number of Seedlings			Hypocotyl Color			
				Red		Green	
	Total	NR	NS	NR	NS	NR	NS
C17/3584	61	11	50				
730/DDR	231	47	184	29	91	18	93
758/DDR	105	20	85	10	49	10	36
765/DDR	41	15	26	9	11	6	15
770/DDR	128	39	89	22	55	17	34
770 BC_2	40	12	28				
771/DDR	60	20	40	12	19	8	21
778/DDR	63	9	54	5	28	4	26
Y831/770	43	10	33				
3584 O.P.	55	14	41	(9)		(5)	
Total	827	197	630	87	253	63	225

1/ Female parents included the male-sterile 0755 and the self-incompatible F80-37 sugarbeet plants.

Table 3. Segregation of nematode resistance and hypocotyl color in the self-fertile 3584 pedigree in reciprocal crosses with line F80-37 sugarbeet.

Female Parents	Number of Seedlings			Hypocotyl Color			
				Red		Green	
	Total	NR	NS	NR	NS	NR	NS
730/DDR	40	21	19	11	9	10	10
758/DDR	47	21	26	13	17	8	9
765/DDR	50	26	24	18	17	8	7
770/DDR	54	17	37	11	22	6	15
770-086R	89	35	54	27	45	8	9
770 BC_2	23	4	19	2	12	2	7
771/DDR	54	27	27	17	19	10	8
775-133R	77	34	43	20	18	14	25
775-133R	43	14	29				
778/DDR	28	15	13	12	10	3	3
Total	505	214	291	131	169	69	93

INTERSPECIFIC HYBRIDIZATION

VULGARIS-PROCUMBENS HYBRIDS

Helen Savitsky

Production of homozygous nematode-resistant lines is necessary for incorporation of nematode resistance into commercial sugarbeet varieties. Two homozygous nematode-resistant plants 55465 and 55235 which transferred the resistance to 100% of their F_1 offspring were obtained in 1980. Because they were pollinated by resistant heterozygotes, the resistant F_1 hybrids consist of homozygous and heterozygous nematode-resistant plants.

In 1981 two methods were used to produce homozygous nematode-resistant lines: (1) Intercrosses of F_1 resistant plants from the first homozygous line (55465 x 55458) and from the second homozygous line (55235 x 55255) transmitted resistance to 100% of their offspring and were used to increase and maintain the group of homozygous and heterozygous plants from which new homozygous plants may be selected. (2) The other F_1 plants from the same hybrids were pollinated by nematode susceptible plants. Those F_1 plants which transferred resistance to 100% of their offspring were intercrossed for production of homozygous nematode-resistant lines. The F_2 progenies of all F1 hybrids were tested for resistance.

Propagation of F_2 nematode-resistant hybrids and investigation of resistance transmission by female and by male gametes from homozygous and heterozygous resistant plants. The F_2 resistant plants from the first and second homozygous plants which derived from transmission of resistance to 100% of F_1 and of F_2 offspring were intercrossed in 1982 and F_3 seeds were released to sugar companies. Some plants in both lines were crossed in bags; the others were propagated in isolated groups to facilitate pollination between different plants. The nematode-resistant lines 55465 x 55458 and 55435 x 55455 differed in the rates of resistance transmission and in vigor and were propagated separately.

The first 10 F_1 homozygous nematode-resistant plants obtained in 1980, which after being pollinated by susceptible plants transferred resistance to all offspring, were intercrossed in 1981. They produced few seed and these are being used for seed production the second time. All offspring of these homozygous F_1 plants were resistant and seed obtained from them were designated as "homozygous population N1" (from F_1 plants). The same experiments were conducted with F_2 progenies of homozygous F_1 hybrids. The F_3 seed obtained from them were designated as "homozygous population N2."

The homozygous resistant plants are new genotypes which previously never existed. They are the products of genetic engineering and contain in the chromosome of *B. vulgaris* a segment of *B. procumbens* chromosome bearing the gene for nematode resistance. The first observations of these plants showed that their anthers and pollen were poorly developed which caused different degrees of sterility in individual plants. It was also observed

that they need higher temperatures than the ordinary diploid sugarbeet (70-72° F. at night and 80° F. during the day) during development of anthers and flowering which improved the dusting of pollen. Some degrees of sterility might be genetically stipulated in interspecific hybrids. In such a case, propagation of homozygous plants and their study and selection of plants showing higher fertility should eliminate this deficiency. However, a great degree of observed abnormalities was caused by environment. Seed germination and hybrid vigor in all nematode-resistant materials were lower in 1981 and 1982 than in preceding years due to unfavorable temperature conditions in the greenhouses during flowering which damaged development and maturation of seed in resistant plants.

Additional quantities of F_3 seed from nematode resistant line (55465 x 55458) and from the line (55435 x 55455) will be released in 1983. Also, the seed from homozygous populations N1 and N2 will be released.

Thanks to support from BSDF and from the California Beet Growers Association (I had one helper working for me for 8 hours during a month), it was possible to produce seed of nematode resistant materials for release and to conduct some investigations. A first step to investigation of homozygous plants is the determination of resistance transmission by female and male gametes in homozygous and in heterozygous plants. Homozygous and heterozygous resistant plants were crossed with nematode susceptible plants. The heterozygous plants were also intercrossed. Twenty plants derived from each group of hybridization were tested for resistance. All offspring from homozygous plants pollinated by susceptible plants were resistant. Also, all offspring of susceptible plants pollinated by homozygous plants were resistant. Of course all these resistant progenies were heterozygous for the resistant character.

Forty percent of the offspring from heterozygous resistant plants pollinated by susceptible plants were resistant. But only 22% of offspring of susceptible plants pollinated by resistant heterozygous plants were resistant. This indicates that pollen bearing the gene N was less effective than normal sugarbeet pollen. Transmission by female gametes was 24% and by male gametes 12% in the first hybrid generations. Data obtained now indicates that although transmission of resistance by female and male gametes increased in later generations, the transmission by pollen is still much lower than by female gametes.

Sixty percent of the progeny of intercrosses of heterozygotes were resistant. Among these were many homozygous plants which could be selected in the following generations. Data obtained are preliminary data. Additional experiments concerning the resistance transmission by different gametes will be conducted.

DEVELOPMENT OF BREEDING LINES AND GERMPLASM
SUMMARY OF ACCOMPLISHMENTS, 1982
R. T. Lewellen and I. O. Skoyen

POPULATION IMPROVEMENT WITHIN 755--A series of tests were run to gain additional knowledge about breeding methods and the response of population 755 to selection. In the first series of tests (1382), hybrid performance of the initial 15 F_2 lines that were composite crossed to form 755 were compared to an advanced population. The advanced population hybrid was superior to all of the initial component lines and suggested that better inbreds could be extracted from the 755 population than were initially available.

In the second series of tests (382), the progress or response of 755 to mass selection for disease resistance and sugar yield was measured in variety hybrids. Mass selection for sugar yield not only was effective at improving host-plant resistance to several diseases (virus yellows, erwinia root rot, and powdery mildew) but also produced a general improvement in combining ability with each cycle of selection. In a comparison of the hybrid performance of the C0, C1, C2, and C3 populations, there was an average sugar yield increase of 4, 6, and 8%, respectively.

In a third test (1982), 24 testcross progenies (S_1 lines from 755 topcrossed to C37) were retested. In the initial progeny test in 1981, 112 testcross progenies were evaluated in a three replication test. The retest with eight replications and good precision suggested that the original progeny test did not produce highly predictive data on the performance of individual lines. It did, however, discriminate the performance of the progenies well enough to be able to identify the superior lines from the inferior lines but would not differentiate those in the intermediate levels. The retest suggested that individual S_1 lines could be identified that had superior hybrid performance for root yield, sucrose concentration, or sugar yield. On the basis of these early generation tests for combining ability, seven lines have been released from the 755 population. These lines were designated C301 through C307. R. T. Lewellen and I. O. Skoyen.

S_1 FAMILY RECURRENT SELECTION--The second cycle of S_1 RS was completed and the results summarized in tests 1182-1, -2, -3, and B482. The results of the second cycle of selection showed that S_1 evaluation and selection are effective means of population improvement. Relative to the unselected check, populations from cycles one and two selected for sugar yield were improved by 9 and 15%, respectively. R. T. Lewellen and I. O. Skoyen.

GENETIC ADVANCE FOR YIELD AND DISEASE RESISTANCE IN SUGARBEET--Testing was continued at Salinas in 1982 to evaluate genetic contribution to sugarbeet yields in California during the past 40+ years, Test 1282. Also, the completed analyses of tests in 1981 are included on the impact of yellows virus disease resistance on yield for the test cultivars, R&G Pioneer, US 15, US 22/3, US 56/2, US 75, US H6, US H7A, and US H10B (Test 2081). Previous tests in this study have been reported or referenced in Sugarbeet Research, 1981 Report, pages A6, A41, A43, and A49. As suggested by earlier tests a

significant portion of the yield increase, in the presence or absence of severe disease stresses, can be attributed to genetic improvement. These tests suggest that a yield plateau has not been reached in sugarbeet yield improvement. Gross sugar yields relative to US 22/3 for the 1981 and 1982 tests are as follows:

Variety	Yr. of Release	Test 2081 (1981) BYV-BWYV Inoc. %	Test 2081 (1981) Non-Inoc. %	Test 1282[1/] (1982) %
US H10B	1970	153	119	135
US H7A	1964	140	125	125
US H6	1960	110	114	115
US 75	1952	98	105	115
US 56/2	1950	106	107	111
US 15	1936	94	113	96
R&G Pioneer	Pre 1940	106	108	98
US 22/3	1948	100	100	100

1/ BWYV natural infection quite severe.

These data demonstrate the continuing upward trend in sugarbeet yields due to genetic improvements. I. O. Skoyen and R. T. Lewellen.

EFFECTS OF MASS SELECTION ON GCA--Four O.P. sources and their advanced lines were evaluated for disease resistance and hybrid performance in 1982 to determine if mass selection has been effective at simultaneously improving host-plant resistance and combining ability. The criterion for individual plant or mass selection for virus yellows resistance has been sugar yield (root weight x % sucrose) of plants uniformly infected with either or both BYV and BWYV. The four O.P. varieties, US 22/3, 468 (US 75), 915 (US 15), and 959 (US 56/2) were the original sources. The corresponding lines derived by mass selection are E937 (11 cycles of sel.), Y930 (5 cycles), Y923 (4 cycles), and Y926 (4 cycles), respectively. The sources and their respective mass selected lines were crossed with the 546H3 F_1 female. Results of a test which compared the hybrid performance of the four O.P. lines and their advanced lines were previously reported in Sugarbeet Research, 1981 Report, pages A3 and A39 (Test 1281). Included in the 1982 report are the completed analyses of a BYV-BWYV inoculated vs. non-inoculated yield test of sources and selections (Test 2281) and a yield test comparing sources and selections inoculated vs. non-inoculated with BWYV (Test 2182). Comparisons of yield test results for source hybrids and selected line hybrids are also reported, Tests 1082-1 and 1082-2. The results of all tests showed definite trends that each source was improved in combining ability by mass selection. Not all sources responded the same: US 56/2 showed improvement primarily for sucrose content and US 15 showed improvement primarily for root yield. Comparisons of sources and their selections for virus yellows resistance in Test 2281 (BYV-BWYV vs. non-inoculated) and Test 2182 (BWYV vs. non-inoculated) show that the major progress in mass selection for resistance has probably been for BWYV. However, improvement in resistance

to virus yellows diseases is a slow process. With exposure to BYV-BWYV eleven cycles of selection from US 22/3 were required to halve yield loss due to infection (Test 2182). Mass selection to increase resistance to BWYV is considerably more effective. An important factor, along with the trend for improved combining ability, is the improved yield potential in the absence of yellows virus disease stress. I. O. Skoyen and R. T. Lewellen.

POWDERY MILDEW--Breeding lines and germplasm being advanced by mass selection are simultaneously evaluated and selected for resistance to virus yellows, erwinia root rot, and powdery mildew. To determine if improvement in resistance to PM has been made and how moderate levels of PM augment chemical (sulfur) control, lines were evaluated in Test 1682 in 1982 and 14 and 1581 in 1981. A split-block design was used in which PM was left uncontrolled and controlled by multiple applications of wettable sulfur. The test was good but high levels of PM did not develop in the uncontrolled plots and there was not total control of PM in the sulfured plots. In Test 1682, the measured losses due to PM ranged from 0.0 to 16.1% and were substantially less than would be expected from a severely diseased trial. C37 showed a loss of 15.5% whereas under severe conditions, losses up to 30% are expected. However, this test demonstrated several important considerations. Improvement in the level of host-plant resistance to PM has been achieved by field selections. In contrast to the 15 to 16% losses for C37 and F81-546H3, losses in selected lines Y146 (C46) and 1755 were significantly less. Based upon mildew scores for controlled and noncontrolled comparisons, the moderate levels of PM resistance augmented the effects of sulfur and provided better control than sulfur did alone in the more susceptible lines. Based upon this test, most of the losses due to PM infection were for root yield with % sucrose less affected. Nonsucrose soluble solids and apparent purity were changed little due to powdery mildew. Powdery mildew susceptible US H11 is a hybrid between F81-546H3 and C36 (similar to C37). It is evident from Test 1682 that these parental lines are highly susceptible and as they are replaced, improvements in resistance to PM should be achieved.

Tests such as 1682 have probably underestimated the damage caused by PM. Complete control of mildew has usually not been obtained in the control plots and disease severity appears to be less in small, nonsprayed plots surrounded by sprayed plants than in adjacent spreader rows of similar varieties. At the disease level in this test, the protection provided by host-plant resistance in C46 and others appeared to be sufficient. However, in severely diseased plots, these same entries appear to be only moderate in resistance. R. T. Lewellen, I. O. Skoyen, E. D. Whitney.

VIRUS YELLOWS--Hybrids and germplasm lines were tested against BWYV in 1982. Three tests were grown: Test 2182 evaluated four open-pollinated lines advanced by mass selections for yellows resistance against their four original sources; Test 2282 evaluated germplasm in development at Salinas; and Test 2382 compared the performance of advanced USDA experimental hybrids and proprietary hybrids.

In Test 2382, BJ 19 demonstrated the potential severity of BWYV on highly susceptible varieties. Under noninoculated conditions, it ranked first out of 16 entries, but when inoculated, ranked 16th with a 36% reduction in sugar yield (from 11,000 lbs. sugar/acre to less than 7,000 lbs./acre).

The hybrids that performed best under inoculated conditions were those involving parental lines from the yellows project. For example, hybrid E137HL2 had a loss of about 12% and gross sugar yield of 9,400 lbs./acre. As demonstrated by Test 2382, the challenge in virus yellows (disease resistance) breeding is to obtain higher productivity in the absence of disease. This is especially true in terms of percent sucrose and extractable sugar per ton. The data for germplasm line Y139 (Test 2282) suggest that some progress is being made in combining better sugar concentration with yellows resistance. However, the composite from which Y139 was produced included a wide array of USA and European germplasm and considerable work remains to improve this germplasm for other host-plant resistances needed in the western United States.

For Tests 2282 and 2382, significant variety x virus treatment interactions occurred for sugar yield, root yield, percent sucrose, and extractable sugar per ton, but not for nonsucrose soluble solids or raw juice apparent purity. In fact, BWYV infection did not change the concentration of nonsucrose soluble solids but did reduce the apparent purity. Thus the reduction in purity was almost entirely due to a decrease in sucrose. Even for the very susceptible line SP6822-0, BWYV did not appreciably change the nonsucrose soluble solids (from 2.72% noninoculated to 2.78% inoculated) but dramatically reduced sucrose from 15.8% to 14.4% and consequently apparent purity changed from one of the higher levels (85.3%) to one of the lower levels (83.8%) when inoculated. R. T. Lewellen and I. O. Skoyen.

DIFFERENTIAL RESPONSE TO LETTUCE INFECTIOUS YELLOWS--The whitefly, *Bemisia tabaci*, transmitted disease lettuce infectious yellows (LIY) was epidemic in the Imperial Valley in 1981-2 and losses in commercial sugarbeet were estimated to be at least 25%. Although not conclusive evidence, the comparison of the performance of nearly equivalent progeny test lines in 1981 (no disease) and 1982 (100% LIY) suggested that considerable genetic variability exists for host-plant reaction.

Range in performance of testcrosses[1/] in Imperial Valley in 1981 and 1982.

	1981 (healthy)	1982 (LIY)
Sugar Yield (lbs/A)	9,000-12,200	3,500-10,500
Root Yield (t/A)	25.4-35.4	15.5-33.2
% Sucrose	16.5-18.7	12.9-17.8
% Clean Roots	94.5-98.1	79.2-96.8

1/ Progeny lines from 755 topcrossed to C37.
r = -0.49** for root yield and % sucrose in 1981.
r = 0.25* for root yield and % sucrose in 1982.

In addition to the apparent differential response of these testcross families to LIY, other lines also appeared to perform differently than expected. The widely used type-O line C546 appeared to be highly susceptible and the multigerm line C31 performed much more poorly than expected relative to C37. In a test of fodder beets, the performance of 'Oscar' was off 50% compared to a 25% decrease in US H11 relative to an equivalent test in 1981. R. T. Lewellen and I. O. Skoyen.

YELLOWS AND POWDERY MILDEW TESTS, 1981--The analyses of Tests 1481, 1581, 1781, 1881, 1981, 2081, 2181, and 2281 were not completed in time to be included in the 1981 Report, Sugarbeet Research. The completed summaries of these tests are included in the 1982 Report. Plot histories of these trials are given on pages A28 and A29 of the 1981 Report.

Tests 1481 and 1581 were designed to measure the losses in a series of hybrids and O.P. lines that differ in powdery mildew reaction. Treatment 1 was with multiple applications of sulfur for PM control. Treatment 2 was without sulfur. The intensity of mildew in these tests was low and occurred late in the season. The reliability of the % loss data is not good.

Tests 1781 through 2281 were designed to measure the relative reaction of hybrids and O.P. lines to virus yellows. Both BYV and BWYV were included as inoculum. There was very little incidence of virus yellows in the experimental field in 1981 and little apparent movement of virus from inoculated to noninoculated blocks. Except for some variability in stands, these appeared to be very good tests. The effects of BYV-BWYV were severe and losses ranged from about 27 to 47% in the hybrids and 19 to 64% in the O.P. lines. The most resistant lines were Y049 (= C37 x C31E2) and C37. The most resistant hybrids were those with C37 as the pollinator and 755 monogerm population as the female. C37 and C37 hybrids were consistently more resistant than C36 and US H11. Under noninfected conditions, C37 and C36 hybrids are similar but under severe yellows, C37 hybrids appear to have a definite advantage over C36 hybrids. R. T. Lewellen, I. O. Skoyen, E. D. Whitney.

ROOT TOUGHNESS--Testing was continued in 1982 on divergent selections for low fiber (soft) and high fiber (tough) sugarbeet roots, and their hybrids, vs. the effect of environment on root fiber. Results from two tests in 1981 (Table 1) and one test in 1982 (Table 2) were similar to those reported in Sugarbeet Research, 1980 Report, pages A5, A53-A56. In general, differences in root toughness from year to year occur but trends are in the same direction, i.e. the soft selection (SS) is usually softer than the parent and the tough selection (ST) significantly tougher than the parent. Toughness of their hybrids generally are intermediate between parent and ST selection, however, for SS differences are not as definite. Plant age in the 1981 tests was the major factor in root toughness with younger plants (Test 2) markedly less tough than in Test 1 (Table 1). The combined 12- to 20-lbf classes from the frequency distribution accounted for 70% of the distribution in 1980 Test 1 and 83% for Test 2. For the 1982 test, the 12- to 20-lbf portion accounted for 70% of the total test population. The mean percentage for SS and ST selections and parent lines of the 12- to 20-lbf portion were:

	1981		1982
	Test 1	Test 2	Test
	%	%	%
Low fiber (SS)	76	88	83
High fiber (ST)	42	65	52
Parent lines	73	82	80

Yield data for the three tests, two in 1981 and the 1982 test, are presented in Table 3.

A second cycle of selection based on single plant probe values (using the Effegi penetrometer described in Sugarbeet Research, 1980 Report) was made in 1982. The selected roots were sawed with a single beet saw and scored for root fiber visible in the saw cut. The mean root scores were then correlated with the mean field penetrometer probe values as follows:

Line	Mean Root Probe Value lbf	Mean Score1/
036SS	15.4	1.8
036ST	27.6	6.2
SY131SS	14.4	1.7
SY131ST	27.4	5.1
Y040SS	13.4	1.3
Y040ST	26.1	5.1
	r = 0.98	

1/ Scored 1-10 with 1 lowest.

The close correlation of field penetrometer values with scoring sawed roots means that large numbers of roots can be probed in the field and reliable selections made based on individual probe values. Seed increases of the second cycle selection will be evaluated for increase in divergent toughness and effect on yield components among the selected lines and their hybrids. I. O. Skoyen and R. T. Lewellen.

FIELD VARIETY TRIALS, SALINAS, CALIFORNIA, 1981-82

Location: USDA-ARS Agricultural Research Station

Soil type: Sandy loam (Chualar series)

Previous crops: 1981-82 Sugarbeet test areas, Spence Field:
Block 1 - north 8.2 acres, fallow 1979-1981; sugarbeet trials, 1978.
Block 2 - north 9.6 acres, fallow 1979-1981; sugarbeet trials, 1978.

Fertilizer and pesticides used: Preplant: Dolomite (equivalent to 105% $CaCO_3$) was broadcast at rates of 1000 lbs/A and disced in about 6" deep. Both 1981-82 test areas had 400 lbs. 5:20:10 applied broadcast and chiseled in. The block 1 test area had 18 gal/A Telone 2 chiseled in (for control of possible sugarbeet nematode infestation) during October 1981. Prior to seeding, about 330 lbs/A ammonium sulfate was Bye Hoe incorporated into a 9-inch band on the bed tops.

Supplemental nitrogen: Two or three applications, as sidedressed ammonium sulfate or by sprinkler irrigation system as 32% nitrogen in a liquid formulation.

Total fertilization (lbs/A):

	N	P_2O_5	K_2O
Block 1	280	80	40
Block 2	240	80	40

Summary: 1982 Tests at Salinas (Spence Field):

Test No.	Sowing Date 1981-1982	Thinning Date 1982	Test Entries No.	Reps No.	Plot Row No.	Plot Row Lgth. Ft.	Harvest Date 1982	Test Design
Block 1								
182	2/3	3/8-12	96	2	1	30	Obs. Test	--
282	2/3	3/8-12	8	8	2	30	9/21-22	RCB
382-1	2/3	3/8-12	8	8	1	30	9/23-28	RCB
482-1	2/3	3/8-12	8	8	1	30	9/23-28	RCB
582	2/3	3/8-12	16	8	2	30	9/20-21	RCB1/
682	2/3	3/8-12	8	8	2	30	9/22-23	RCB
782	2/2	3/8-12	8	8	2	30	9/29	RCB
882	2/2	3/8-12	16	8	2	30	9/29- 10/1	RCB1/
982-1	2/2	3/8-12	96	1	1	30	10/28	3/
1382-1	2/2	3/8-12	16	2	1	30	10/28	RCB
1082-1	2/2	3/8-12	8	8	2	30	10/15	RCB
1182-1	2/2	3/8-12	8	8	2	30	10/4-5	RCB
1282	2/2	3/8-12	8	8	2	30	10/4-5	RCB
382-2	2/23	4/5-7	8	8	1	30	10/15	RCB
482-2	2/23	4/5-7	8	8	1	30	10/8	RCB
1482	2/24	4/5-7	16	8	2	30	10/5-6	RCB1/
1582	2/23	4/5-7	16	8	2	30	10/12-13	RCB1/

Test No.	Sowing Date 1981-1982	Thin-ning Date 1982	Test Entries No.	Reps No.	Plot Row No.	Plot Row Lgth. Ft.	Harvest Date 1982	Test Design
982-2	2/23	4/5-7	96	1	1	30	10/27	3/
1382-2	2/23	4/5-7	16	2	1	30	10/27	RCB
1082-2	2/23	4/5-7	8	8	2	30	10/7-8	RCB
1182-2	2/23	4/5-7	8	8	2	30	10/7	RCB
1682	2/24	4/5-7	16	8	1	30	10/13-14	SB
1782	2/24	4/5-7	48	2	1	30	Obs. Test	RCB
Block 2								
1882 4/	4/29	5/24-28	20	6	4	22	10/27	RCB
382-3	4/30	5/24-28	8	8	1	37	10/20	RCB
982-3	4/30	5/24-28	96	1	1	37	10/29	3/
1382-3	4/30	5/24-28	16	2	1	37	10/29	RCB
1982	4/30	5/24-28	32	8	1	37	10/18-19	RCB
1182-3	4/30	5/24-28	8	8	2	37	10/19-20	RCB
2082	4/30	5/24-28	28	4	1	37	11/16	RCB
2182	4/30	5/24-28	8	8	1	37	11/15	SB(LS) 2/
2282	4/30	5/24-28	16	8	1	37	11/2-3	SB
2382	5/1	5/24-28	16	8	1	37	11/4-5	SB
5/	5/19	6/23-25	23	-	-	77	12/7-9	--

1/ RCB* = Each variety occurs once in each pair of rows.
2/ SB(LS) = Split Block with varieties in Latin square.
3/ Incomplete Block.
4/ Fuel (fodder) beet test 14
5/ Mother root selection block for resistance to VY, ERR, PM, and yield.

Irrigation: By either furrow or sprinkler system as required at 7-14 day intervals except during stand establishment when frequent light sprinkler irrigations were used.

Herbicide use: Pyramin W, at an average rate of 3.75 lbs/A, was sprayed post plant and watered in with 1/2 to 3/4 inch sprinkler irrigation.

Diseases and insects: Natural virus yellows infection was severe throughout tests seeded February 2-3, 1982 (Tests 182 through 1282, Block 1), moderate for tests seeded 2/23-24, and light for tests seeded 4/29 - 5/1.

All Tests, inoculated and noninoculated, were sprayed with Meta Systox R by aircraft for BWYV vector and general aphid control on June 26, 1982 with 3 pints/A.

Powdery mildew infection was moderately severe in 1982 where it was not controlled and appeared first (mid-June) in the earliest seeded tests. The degree of control, with the application of sulfur appeared to be good. Two to four spray applications of wettable sulfur at rates of 15 to 20 lbs/A were made on June 14, July 12-13, August 16, and September 7, 1982. Some differential responses in yield probably occurred due to PM infection.

Downy mildew infection was a minor disease problem in 1982.

Natural infection of Erwinia soft rot was light in susceptible lines and had minimum effect on yield in 1982.

Sugarbeet nematode infestation was observed in Block 2 where test plot areas were not fumigated with Telone 2. The Block 1 test plot area was fumigated with Telone 2 at 18 gal/A October 22, 1981.

Earwigs were severe in tests planted in April and May and were controlled with sevin bait.

Worms were of little importance and no control was required.

Rhizomania and foliar yellowing type symptoms occurred in certain sandy areas of Block 2 and caused yield reductions. The etiology of these symptoms was investigated but not determined.

Sugar analysis: Determined from two samples per plot of approximately 10 roots each or 25-40 lbs. of roots at the sugar analytical laboratory, U.S. Agricultural Research Station, Salinas, California.

Remarks: Test results should be generally reliable for 1982. Rain interrupted harvest on several occasions and caused a reduction in % sucrose, but less severe than in nearby commercial fields.

The assistance of Dr. F. J. Hills and Ms. Patricia Thomas, University of California at Davis, in the analysis of test data is gratefully acknowledged.

TEST 582. HYBRID PERFORMANCE OF GERMPLASM LINES, SALINAS, CALIFORNIA, 1982

16 varieties, 8 replications, RCB
2-row plots, 30 ft. long

Planted: February 3, 1982
Harvested: September 20-21, 1982

Variety	Description[1/]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot
		Lbs	Tons	%	Number	%
E137HL2	0755aa x F80-37	11,344	36.88	15.39	124	0.2
E137HL6	0755-29aa x F80-37	11,251	37.07	15.16	122	0.0
E137HL4	0757aa x F80-37	10,976	35.49	15.45	127	0.0
Y131HL7,8	0796-1,-2aa x Y031	10,331	33.53	15.41	120	0.2
E137HL44	9790Daa x F80-37	10,297	33.72	15.26	124	0.0
Y146H8	546H3 x Y046	10,242	33.05	15.16	117	0.2
E137H8	546H3 x F80-37	10,206	34.29	14.88	126	0.2
E137HL39	0742aa x F80-37	10,150	33.13	15.31	124	0.2
E137HL37	0740aa x F80-37	10,099	32.62	15.48	130	0.0
E137HL38	0741aa x F80-37	9,951	32.39	15.34	131	0.2
E137HL40	0744aa x F80-37	9,939	31.89	15.60	135	0.0
Y131H8	546H3 x Y031	9,892	33.05	14.96	121	0.7
US H11	546H3 x C36 (80096)	9,835	33.78	14.54	124	0.2
U137H8	546H3 x F80-37 (81060)	9,787	32.86	14.92	127	0.2
E137HL41	0745aa x F80-37	9,695	31.68	15.29	124	0.0
1757HL9	0747aa x 0755	9,667	33.45	14.43	118	0.0
Mean		10,229	33.72	15.16	125	0.1
LSD (.05)		793	2.25	0.55	NS	NS
Coefficient of Variation(%)		7.8	6.7	3.6	9.2	320
F value		3.4**	3.8**	2.9**	1.3NS	1.4NS

1/ 0740, 0741, 0742, 0744, 0745, 0755, 0757, 9790D, and 0796 = S^f, mm, A:aa populations; 0755-29 = C301; 0747 = S^f, M, A:aa population; F80-37 = C37; Y031 = YR C31E2; 546H3 = C562CMS x C546.

Note: Natural infection with BWYV was severe.

TEST 882. HYBRID PERFORMANCE OF MULTIGERM GERMPLASM LINES, SALINAS, CALIFORNIA, 1982

16 varieties x 8 replications, RCB
2-row plots, 30 ft long

Planted: February 2, 1982
Harvested: September 29-30, 1982

Variety	Description[1/]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot
		Lbs	Tons	%	Number	%
E137HL1	0755HO x F80-37	10,913	36.92	14.78	131	0.0
E137HL6	0755-29aa x F80-37	10,564	35.52	14.88	117	0.0
Y146HL1	0755HO x Y046	10,227	34.13	14.98	126	0.2
E137H4	F67-563HO x F80-37	10,129	34.70	14.61	127	0.1
E137H8	546H3 x F80-37	10,026	34.31	14.61	124	0.0
Y152H8	546H3 x Y052	10,011	33.77	14.82	133	0.3
E137H6	F80-566CMS x F80-37	9,928	33.56	14.78	126	0.2
U031H8	546H3 x F79-31 (80212)	9,900	33.01	14.99	124	0.3
Y149H8	546H3 x Y049	9,878	33.35	14.80	122	0.2
Y141H8	546H3 x Y041	9,837	32.97	14.92	124	0.7
Y052H8	546H3 x Y952	9,761	33.21	14.71	119	0.9
US H11	546H3 x C36 (80096)	9,737	33.61	14.49	136	0.0
Y131H8	546H3 x Y031	9,713	32.82	14.78	123	1.5
Y146H8	546H3 x Y046	9,700	32.05	15.14	125	0.0
Y049H8	546H3 x Y949	9,584	33.10	14.48	135	0.0
U137H8	546H3 x F80-37 (81060)	9,276	32.02	14.49	133	0.2
Mean		9,949	33.69	14.77	127	0.28
LSD (.05)		486	1.47	0.30	NS	0.6
Coefficient of Variation(%)		4.9	4.4	2.1	12.4	224
F value		4.9**	5.6**	3.2**	1.0NS	8.9**

1/ 546H3 = C562CMS x C546; 0755-29 = C301; 0755HO = CMS of S^f, mm, A:aa population; F67-563HO = C563 CMS; F80-37 = C37.

Note: Natural infection with BWYV was severe.

TEST 1482. EVALUATION OF ADVANCED USDA AND COMPANY HYBRIDS, SALINAS, CALIFORNIA, 1982

16 varieties x 8 replications, RCB
2-row plots, 30 ft. long

Planted: February 24, 1982
Harvested: October 5-6, 1982

Variety	Description1/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	Bolting	Non Sucrose SS	Raw J. App. Pur.	Extract. Sugar2/
		Lbs.	Tons	%	Number	%	%	%	%	Lbs./T
Y131HL1	0755H0 x Y031	11,406	37.45	15.26	134	0.9	0.0	2.85	84.2	257
Y049H33	3546H72 x Y949	11,304	37.76	14.99	123	0.3	0.0	2.99	83.4	250
BJ 19	Bush-Johnsons (1/82)	11,222	34.36	16.31	137	0.9	0.0	2.75	85.5	279
Y146H72	C718H0 x Y046	11,173	37.08	15.13	124	0.2	0.0	2.81	84.3	255
81-7335-05	Holly (12/81)	11,133	36.79	15.18	127	2.1	0.2	2.68	84.9	258
E0206	Amal. (1/82)	10,986	36.56	15.04	134	0.0	0.0	2.99	83.4	251
US H11	546H3 x C36 (80096)	10,971	36.30	15.17	139	0.0	0.0	2.69	84.9	258
E137HL29	0546H72 x F80-37	10,899	37.21	14.69	135	0.0	0.0	2.68	84.6	249
81-7334-05	Holly (1/82)	10,875	35.54	15.39	121	1.0	0.0	2.73	84.9	261
1C0104	Betaseed (1/82)	10,860	35.83	15.19	127	0.0	0.7	2.80	84.4	257
81-7334-03	Holly (1/82)	10,834	34.24	15.87	126	0.0	0.0	3.02	84.0	267
S-311H	Spreckels (1/82)	10,682	34.25	15.59	130	0.8	0.0	2.91	84.3	263
0G5545	Betaseed (1/82)	10,466	35.80	14.66	132	0.2	0.0	2.80	84.0	246
E0207	Amal. (1/82)	10,411	34.31	15.18	134	0.0	0.0	3.05	83.2	253
S-101H16	Spreckels (1/82)	10,163	34.77	14.70	128	1.9	0.0	2.97	83.1	245
SS-Z1	Spreckels (1/82)	10,014	32.11	15.68	129	0.2	0.0	2.94	84.2	264
Mean		10,837	35.65	15.25	130	0.5	0.1	2.85	84.2	257
LSD (.05)		734	1.89	0.54	9.9	1.1	0.2	0.19	1.0	10.6
C. V. (%)		6.8	5.4	3.6	7.7	201	415	6.7	1.2	4.2
F value		2.3**	5.2**	5.3**	2.2**	3.3**	4.9**	3.7**	3.8**	5.3**

1/ 0755H0 = CMS counterpart of monogerm 755 population. Y031 = YR C31/2. Y949 = F_1(C37 x C31/2).
0546H72 and 3546H72 = C718CMS x C546. 546H3 = C562CMS x C546.

2/ Estimate of extractable sugar per ton based on 0.2 x %S x RJAP.

Note: Natural infection with BWYV was moderately severe. Powdery mildew and other disease incidence was low.

TEST 1582. EVALUATION OF ADVANCED USDA HYBRIDS, SALINAS, CALIFORNIA, 1982

16 varieties x 8 replications, RCB
2-row plots, 30 ft. long

Planted: February 23, 1982
Harvested: October 12-13, 1982

Variety	Description1/	Acre Yield Sugar Lbs.	Acre Yield Beets Tons	Sucrose %	Beets/ 100' Number	Root Rot %	Non Sucrose SS %	Raw J. App. Pur. %	Extract. Sugar Lbs./T
Y141H8	546H3 x Y041	11,688	36.77	15.91	145	0.1	2.68	85.6	272
E137HL6	0755-29aa x F80-37	11,548	37.10	15.57	130	0.3	2.86	84.4	263
Y152H8	546H3 x Y052	11,351	36.25	15.68	144	0.8	2.68	85.4	268
E137HL29	0546H72 x F80-37	11,299	37.38	15.15	136	0.0	2.69	84.9	257
E137H72	C718H0 x F80-37	11,289	37.23	15.18	136	0.0	2.62	85.3	259
E137HL30	0546HL7 x F80-37	11,101	35.60	15.61	138	0.6	2.84	84.6	264
E037H33	3546H72 x E937 (C37)	11,073	35.75	15.53	138	0.0	2.73	85.0	264
Y149H8	546H3 x Y049	11,012	35.68	15.50	144	0.3	2.78	84.8	263
Y131H8	546H3 x Y031	11,001	35.15	15.66	136	1.2	2.90	84.3	264
E137HL4	0757aa x F80-37	10,827	34.86	15.56	134	0.2	2.89	84.3	263
E037H27	C758H0 x E937 (C37)	10,769	34.24	15.73	140	0.2	2.77	85.0	268
Y146H8	546H3 x Y046	10,713	33.65	15.93	139	0.2	2.93	84.4	269
E137H4	F67-563H0 x F80-37	10,696	35.04	15.25	148	0.2	2.77	84.6	258
E137HL28	0546H27 x F80-37	10,567	33.81	15.63	144	0.1	2.81	84.8	265
E137H8	546H3 x F80-37	10,490	33.90	15.49	146	0.0	2.87	84.3	261
US H11	546H3 x C36 (80096)	10,283	34.49	14.94	142	0.2	2.57	85.3	255
Mean		10,982	35.43	15.52	140	0.3	2.78	84.8	263
LSD (.05)		719	2.17	0.38	8.6	0.6	NS	NS	7.8
C. V. (%)		6.6	6.2	2.5	6.2	245	8.4	1.3	3.0
F value		2.3**	2.6**	4.0**	2.6**	2.2**	1.6 NS	1.1 NS	2.7**

1/ 546H3 = C562CMS x C546. 0755-29 = C301. 0546H72 and 3546H72 = C718CMS x C546. 0546H27 = C758CMS x C546. Y041 = YR-ER (C01 x C64). Y052 = F_2(C37 x Y41). Y049 = F_2(C37 x C31/2). Y031 = YR C31/2. Y046 = YR-ER (C17*2 x C64).

Note: Natural infection with BWYV was moderately severe.

TEST 282. PERFORMANCE OF 755H0 HYBRIDS WITH PARENTAL, F_1, AND F_2 POLLINATORS
SALINAS, CALIFORNIA, 1982

8 replications x 8 varieties, RCB
2-row plots, 30 ft. long

Planted: February 3, 1982
Harvested: September 21-22, 1982

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/100' Number	Root Rot Percent	Bolting Percent
Y049HL7	8755H0 x Y949	11,235	36.17	15.53	129	0.3	0.0
Y149HL1	0755H0 x Y049	11,231	36.06	15.57	132	0.2	0.0
E137HL1	0755H0 x F80-37	11,231	35.96	15.60	125	0.0	0.0
Y052HL7	8755H0 x Y952	11,209	36.73	15.27	132	0.5	0.5
Y146HL1	0755H0 x Y046	11,208	35.55	15.75	122	0.4	0.0
Y141HL1	0755H0 x Y041	11,058	35.30	15.68	121	0.3	0.0
Y152HL1	0755H0 x Y052	10,964	35.81	15.30	125	0.0	0.2
Y131HL1	0755H0 x Y031	10,957	35.01	15.65	126	0.5	0.0
Mean		11,136	35.82	15.54	127	0.3	0.1
LSD (.05)		NS	NS	NS	NS	NS	NS
C. V. (%)		7.3	7.3	3.5	7.6	226.7	453.9
F value		0.2 NS	0.3 NS	0.8 NS	1.5 NS	0.8 NS	1.7 NS

1/ Y949 = F_1(C37rr x C31/2R)Rr. Y049 = F_2(C37rr x C31/2R). Y952 = F_1(C37rr x Y41R)Rr. Y052 = F_2(C37rr x Y41R). Y041 = YR-ER (C64 x C01). Y046 = YR-ER [C17 x (C64 x C17)]. 8755H0 and 0755H0 = near CMS equivalent of S^f, mm population 755.

Note: Natural infection with BWYV was quite severe.

TEST 682. PERFORMANCE OF C718H0 HYBRIDS WITH PARENTAL, F_1, AND F_2 POLLINATORS
SALINAS, CALIFORNIA, 1982

8 replications x 8 varieties, RCB
2-row plots, 30 ft. long

Planted: February 3, 1982
Harvested: September 22-23, 1982

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot
		Pounds	Tons	Percent	Number	Percent
Y149H72	9718H0 x Y049	11,121	36.75	15.13	133	0.2
Y131H72	9718H0 x Y031	11,037	36.33	15.19	117	0.2
Y152H72	9718H0 x Y052	10,851	35.95	15.09	120	0.7
Y049H72	9718H0 x Y949	10,784	35.70	15.07	128	0.0
Y052H72	9718H0 x Y952	10,740	35.71	15.01	124	0.7
Y141H72	9718H0 x Y041	10,688	35.32	15.12	120	0.2
E137H72	9718H0 x F80-37	10,665	36.14	14.76	126	0.2
Y146H72	9718H0 x Y046	10,395	33.71	15.41	121	0.2
Mean		10,785	35.70	15.10	124	0.3
LSD (.05)		NS	NS	NS	NS	NS
C. V. (%)		7.2	5.7	4.2	12.30	222.40
F value		0.7 NS	1.6 NS	0.6 NS	0.9 NS	1.5 NS

1/ See footnote for test 282. 9718H0 = C718CMS.

Note: Natural infection with BWYV was quite severe.

TEST 482-1. PERFORMANCE OF (C718CMS X RM) X C37 HYBRIDS, SALINAS, CALIFORNIA, 1982

8 replications x 8 varieties, RCB
1-row plots, 30 ft. long

Planted: February 3, 1982
Harvested: September 23 & 28, 1982

Variety	Description[1/]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot
		Pounds	Tons	Percent	Number	Percent
E137HL25	(C718CMS x 0755) x F80-37	11,476	39.00	14.70	127	0.0
E137HL20	(C718CMS x 0740) x F80-37	11,412	38.22	14.93	130	0.3
E137H72	C718CMS x F80-37	11,342	40.03	14.14	130	0.0
E137HL22	(C718CMS x 0742) x F80-37	11,246	38.59	14.57	129	0.0
E137HL23	(C718CMS x 0744) x F80-37	11,126	37.61	14.76	123	0.0
E137H8	(C562CMS x C546) x F80-37	11,117	37.44	14.85	137	0.3
E137HL24	(C718CMS x 0745) x F80-37	11,062	37.80	14.63	130	0.0
E137HL21	(C718CMS x 0741) x F80-37	11,032	37.05	14.88	127	0.0
Mean		11,227	38.22	14.68	129	0.1
LSD (.05)		NS	NS	0.40	NS	NS
C. V. (%)		5.8	5.6	2.7	9.2	574.7
F value		0.5 NS	1.6 NS	3.2**	0.9 NS	0.8 NS

1/ RM = Self-fertile, monogerm, near-type-O, random-mating populations 740, 741, 742, 744, 745, and 755. RM populations have had multiple cycles of selection for disease resistance and are potential sources for extracting T-O, monogerm lines. Released lines C301 through C307 were extracted from population 755. An earlier generation of 744 was released as C789.

Note: Virus yellows infection was moderately severe.

TEST 482-2. PERFORMANCE OF (C718CMS X RM) X C37 HYBRIDS, SALINAS, CALIFORNIA, 1982

8 replications x 8 varieties, RCB
1-row plots, 30 ft. long

Planted: February 23, 1982
Harvested: October 8, 1982

Variety	Description1/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	Bolting
		Pounds	Tons	Percent	Number	Percent	Percent
E137H72	C718CMS x F80-37	11,575	38.16	15.26	137	0.0	0.0
E137HL25	(C718CMS x 0755) x F80-37	11,521	38.63	14.94	134	0.0	0.0
E137HL22	(C718CMS x 0742) x F80-37	11,243	37.55	15.02	134	0.3	0.0
E137HL23	(C718CMS x 0744) x F80-37	10,921	35.34	15.51	136	0.4	0.0
E137HL20	(C718CMS x 0740) x F80-37	10,681	34.76	15.43	131	0.7	0.3
E137HL24	(C718CMS x 0745) x F80-37	10,595	35.07	15.17	134	0.0	0.0
E137HL21	(C718CMS x 0741) x F80-37	10,506	34.47	15.30	139	0.0	0.0
E137H8	(C562CMS x C546) x F80-37	10,315	33.52	15.46	137	0.0	0.0
Mean		10,919	35.94	15.26	135	0.2	0.04
LSD (.05)		674	2.04	NS	NS	NS	NS
C. V. (%)		6.1	5.7	2.7	7.4	377.3	800.0
F value		4.1**	7.0**	2.0 NS	0.6 NS	1.3 NS	1.0 NS

1/ RM = Random-mating populations. See footnote 1, test 482-1.

Note: Virus yellows infection less severe than for test 482-1.

TEST 782. PERFORMANCE OF (CMS X C546) X C37 HYBRIDS, SALINAS, CALIFORNIA, 1982

8 replications x 8 varieties, RCB
2-row plots, 30 ft. long

Planted: February 2, 1982
Harvested: September 29, 1982

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot
		Pounds	Tons	Percent	Number	Percent
E137HL5	0755-29H0 x F80-37	11,365	38.96	14.59	128	0.0
E137H72	9718H0 x F80-37	10,897	38.07	14.31	121	0.2
E137HL29	0546H72 x F80-37	10,510	36.60	14.36	126	0.3
E037H33	3546H72 x E937	10,382	35.40	14.68	117	0.0
E137HL30	0546HL7 x F80-37	10,283	35.37	14.54	121	0.2
E137HL28	0546H27 x F80-37	9,991	33.47	14.94	136	0.0
E137H8	546H3 x F80-37	9,976	34.42	14.50	125	0.2
E137HL27	0546H26 x F80-37	9,526	32.85	14.51	131	0.2
Mean		10,367	35.64	14.55	126	0.2
LSD (.05)		894	3.08	0.36	NS	NS
C. V. (%)		8.6	8.6	2.4	14.2	330.1
F value		3.3**	3.9**	2.4*	0.9 NS	0.6 NS

1/ 0755-29H0 = C301CMS. 9718H0 = C718CMS. 0546H72 and 3546H72 = C718CMS x C546. 0546HL7 = 755CMS x C546. 0546H27 = C758CMS x C546. 546H3 = C562CMS x C546. 0546H26 = C779CMS x C546.

Note: Natural infection with BWYV was quite severe.

TEST 1282. GENETIC IMPROVEMENT IN SUGAR YIELD, SALINAS, CALIFORNIA, 1982

8 replications x 8 varieties, RCB
2-row plots, 30 ft. long

Planted: February 2, 1982
Harvested: October 4-5, 1982

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/100' Number	Root Rot Percent	Bolting Percent
917H8	546H3 x 417 (US H10B)	9,060	30.77	14.74	132	1.2	0.0
964H8	546H3 x 364 (US H7A)	8,370	28.74	14.57	132	0.7	0.0
964H2	4547H1 x 364 (US H6)	7,751	26.70	14.56	127	1.8	0.0
968	Inc. 468 (US 75)	7,719	26.57	14.54	126	0.0	0.0
959	Inc. 959 (US 56/2)	7,471	25.42	14.69	124	0.9	0.0
Y009	Inc. US 22/3	6,716	22.87	14.71	117	0.0	18.6
Y905	Inc. 68-9163 (R&G P.)	6,596	22.05	14.96	115	1.8	1.8
915	Inc. 915 (US 15)	6,441	22.90	14.04	117	0.8	0.0
Mean		7,515	25.75	14.60	124	0.9	2.5
LSD (.05)		637	1.96	0.50	8.3	1.1	3.3
C. V. (%)		8.4	7.6	3.4	6.7	120.6	127.5
F value		16.6**	19.7**	2.3*	5.3**	3.4**	32.0**

1/ Except for Y009, entries are 1979 USDA productions of O.P. and hybrid varieties grown extensively in California between 1940 and 1980.

Note: Natural infection with BWYV was quite severe.

TEST 1982. RETEST OF E037HL16 TX'S1/ BASED ON 1981 PROGENY TEST RESULTS, SALINAS, CALIFORNIA, 1982

32 varieties, 8 replications, RCB
1-row plots, 37 ft. long

Planted: April 30, 1982
Harvested: October 18-19, 1982

Variety	Description2/	Sugar Yield Sugar Lbs.	Sugar Yield Beets Tons	Sucrose %	Beets/ 100' Number	Root Rot %	Soluble Solids %	Non Sucrose SS %	RJAP %	Extract. Sugar Lbs./T
E037HL16-125	755-125aa x C37	11,621	34.73	16.73	127	0.0	19.36	2.64	86.4	289
E037HL16-27	755-27aa x C37	11,520	33.99	16.95	129	0.0	19.68	2.73	86.2	292
E137HL6	755-29aa x C37	11,287	34.11	16.56	123	0.3	19.31	2.74	85.8	284
E037HL16-82	755-82aa x C37	11,282	33.44	16.88	127	0.0	19.64	2.76	85.9	290
E037HL15	Popn. 9755aa x C37	11,259	33.56	16.78	130	0.3	19.50	2.73	86.1	289
E037HL16-96	755-96aa x C37	11,166	35.62	15.68	126	1.1	18.15	2.48	86.4	271
E037HL16-18	755-18aa x C37	11,163	32.42	17.22	128	0.0	20.11	2.89	85.6	295
E037HL16-89	755-89aa x C37	11,162	34.36	16.23	126	0.0	18.79	2.56	86.4	280
E037H72	C718HO x C37	11,139	34.82	16.00	122	0.0	18.79	2.79	85.2	273
E037HL16-86	755-86aa x C37	11,070	34.59	16.01	129	0.3	18.52	2.51	86.5	277
E037HL16-34	755-34aa x C37	11,037	32.70	16.89	127	0.3	19.48	2.59	86.7	293
E037HL16-10	755-10aa x C37	10,991	32.69	16.83	122	0.3	19.62	2.79	85.8	289

1/ In 1980, S_1 lines from 8755 population were rogued to genetic male steriles and topcrossed to C37 (E837). In 1981, 112 of these half-sib (testcross) families were evaluated in progeny tests at Salinas. Based upon the initial progeny tests, 24 progenies were retested in 1982.

2/ Test consisted of 32 entries. Eight checks were included: US H11 = 546H3 x C36, E037H8 = 546H3 x C37, C718HO x C37, C563HO x C37, 755-29aa (C301) x C37, (C718HO x C546) x C37, 9744aa x C37, and reselected population 9755aa x C37. The 24 progenies that were retested were divided into four groups based upon 1981 results: TX's with the highest sugar yield (755-27, -82, -10, -35, -125, -127, -18, -96, -77, -52 -105, -68, and -34); TX's with lowest sugar yield (755-48, -31, -104); TX's with highest % sucrose (755-119, -117, -43, -112, -133, -128); and TX's with lowest % sucrose (755-86, and -89). Increases of S_1 lines 755-27, -29, -35, -52, -82, -110, and -119 were released as lines C301 through C307, respectively. TX of 755-110 was not retested due to insufficient seed. Cycle 1 synthetics from this program will be evaluated in 1983.

TEST 1982. RETEST OF E037HL16 TX'S BASED ON 1981 PROGENY TEST RESULTS, SALINAS, CALIFORNIA, 1982 (Cont'd.)

32 varieties, 8 replications, RCB
1-row plots, 37 ft. long

Planted: April 30, 1982
Harvested: October 18-19, 1982

Variety	Description	Sugar Yield Sugar	Sugar Yield Beets	Sucrose	Beets/ 100'	Root Rot	Soluble Solids	Non Sucrose SS	RJAP	Extract. Sugar
		Lbs.	Tons	%	Number	%	%	%	%	Lbs./T
E037HL16-31	755-31aa x C37	10,915	32.77	16.65	117	0.0	19.13	2.48	87.1	290
E037HL16-119	755-119aa x C37	10,911	33.33	16.36	122	0.3	18.82	2.46	86.9	284
E037HL16-127	755-127aa x C37	10,815	33.19	16.28	128	0.0	19.06	2.77	85.5	278
E037HL16-133	755-133aa x C37	10,808	31.04	17.41	130	0.0	20.31	2.90	85.7	299
E037HL16-128	755-128aa x C37	10,799	32.31	16.70	129	0.0	19.31	2.61	86.5	289
E037HL16-48	755-48aa x C37	10,789	32.53	16.59	118	0.6	19.32	2.74	85.9	285
E037HL16-43	755-43aa x C37	10,768	30.29	17.76	131	0.0	20.71	2.95	85.8	305
E037HL16-112	755-112aa x C37	10,762	30.89	17.42	136	0.0	20.63	3.21	84.5	294
E037HL16-35	755-35aa x C37	10,679	31.99	16.69	118	0.3	19.44	2.75	85.9	287
E037HL16-77	755-77aa x C37	10,617	30.41	17.46	125	0.0	20.49	3.04	85.2	297
E037HL16-52	755-52aa x C37	10,518	31.04	16.94	137	0.3	19.69	2.74	86.1	292
E037HL16-68	755-68aa x C37	10,484	32.75	16.00	122	0.0	18.39	2.39	87.0	278
US H11	546H3 x C36	10,368	32.04	16.18	127	0.0	18.99	2.81	85.2	276
E037HL16-105	755-105aa x C37	10,323	31.36	16.48	130	0.0	19.45	2.98	84.7	279
E037HL16-117	755-117aa x C37	10,251	30.56	16.75	138	0.0	19.60	2.85	85.5	286
E137HL29	546H72 x C37	10,141	31.01	16.35	134	0.0	19.20	2.85	85.2	279
E037H8	546H3 x C37	10,118	30.54	16.57	132	0.0	19.39	2.81	85.5	283
E137H4	C563H0 x C37	10,116	31.45	16.08	126	0.0	18.72	2.64	85.9	276
E037HL12	9744aa x C37	9,916	29.65	16.71	130	0.0	19.63	2.92	85.2	284
E037HL16-104	755-104aa x C37	9,797	27.72	17.71	131	0.8	20.60	2.89	86.0	304
Mean		10,768	32.31	16.68	127	0.2	19.43	2.75	85.9	286
LSD (.05)		704	1.99	0.40	8.9	0.6	0.49	0.23	1.0	8.1
C. V. (%)		6.6	6.30	2.40	7.1	383.3	2.60	8.40	1.2	2.9
F value		3.4**	6.0**	12.6**	2.7**	1.8**	13.2**	5.0**	3.1**	8.7**

TEST 382-1. CHANGES IN HYBRID PERFORMANCE OF 755 POPULATIONS, SALINAS, CALIFORNIA, 1982

8 replications x 8 varieties, RCB
1-row plots, 30 ft. long

Planted: February 3, 1982
Harvested: September 23; 28, 1982

Variety	Description[1/]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot
		Pounds	Tons	%	Number	%
E137HL2	0755aa x F80-37	11,976	40.35	14.84	127	0.0
E137HL33	6755aa x F80-37	11,712	39.83	14.71	133	0.7
E137HL32	7755aa x F80-37	11,566	39.47	14.66	130	0.3
E137H8	F78-546H3 x F80-37	11,499	39.53	14.54	132	0.0
E137HL31	8755aa x F80-37	11,498	38.72	14.86	123	0.0
E137HL36	3755aa x F80-37	11,365	39.38	14.44	123	0.4
E137HL35	4755aa x F80-37	10,835	36.90	14.67	124	0.0
E137HL46	1755aa x F80-37	10,823	37.30	14.51	122	0.4
Mean		11,409	38.93	14.65	127	0.2
LSD (.05)		696	NS	NS	NS	NS
C. V. (%)		6.1	6.6	3.1	9.1	437.9
F value		2.7*	1.8 NS	0.9 NS	1.1 NS	0.6 NS

1/ The tested 755 populations represent the initial composite cross through the third cycle of mass selection for disease resistance and sugar yield. These populations were topcrossed to a common tester to determine how their hybrid performance had changed. The populations were advanced from 1755 (CO-M-) to 3755 (CO-mm), 4755 (CO), 7755 (C1), 8755 (C2), and then to 0755 (C3). Population 6755 was a selection out of the direct line of descent. Stecklings of these populations were produced in Oregon, transplanted to a field isolation plot at Salinas, and the plants rogued to genetic male steriles (aa) and topcrossed with C37. The widely used female 546H3 was used as a check.

Variety hybrids were evaluated in three tests in 1982 at Salinas. Virus yellows (BWYV) was quite severe in the first test (382-1), moderate in the second (382-2), and light in the third (382-3). Otherwise, disease exposure was light. In general, the three CO populations had similar performance, whereas there was a general trend for yield improvement with each cycle of mass selection. A portion of this improvement may be due to increased disease resistance. However, most of the improvement would appear to be due to improved combining ability. On the basis of these results and from other disease evaluation trials, mass selection appeared to be an effective way to improve the 755 population. Although not available for testing at the time, two additional cycles of mass selection (cycle 5) have been completed in the 755 population and should produce a monogerm source from which parental lines can be extracted that combine host-plant resistance to virus yellows, curly top, erwinia root rot, and powdery mildew and that possess better hybrid performance than the widely used 546H3 = (C562 x C546) F_1 seed bearing parent of US H11.

TEST 382-2. CHANGES IN HYBRID PERFORMANCE OF 755 POPULATIONS
SALINAS, CALIFORNIA, 1982

8 replications x 8 varieties, RCB
1-row plots, 30 ft. long

Planted: February 23, 1982
Harvested: October 15, 1982

Variety	Description[1/]	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose %	Beets/ 100' Number	Root Rot %
E137HL33	6755aa x F80-37	12,125	38.46	15.79	132	0.9
E137HL31	8755aa x F80-37	11,959	37.25	16.08	139	0.6
E137H8	F78-546H3 x F80-37	11,350	35.81	15.90	133	0.3
E137HL2	0755aa x F80-37	11,231	35.44	15.92	130	0.0
E137HL36	3755aa x F80-37	11,102	36.51	15.29	136	0.0
E137HL32	7755aa x F80-37	10,983	35.53	15.57	129	0.3
E137HL35	4755aa x F80-37	10,966	34.82	15.79	128	0.0
E137HL46	1755aa x F80-37	10,735	33.96	15.86	127	1.3
Mean		11,306	35.97	15.77	132	0.4
LSD (.05)		804	2.26	NS	NS	NS
C. V. (%)		7.1	6.3	3.4	7.7	245.4
F value		3.0*	3.2**	1.7 NS	1.3 NS	1.6 NS

1/ See footnote for test 382-1.

TEST 382-3. CHANGES IN HYBRID PERFORMANCE OF 755 POPULATIONS
SALINAS, CALIFORNIA, 1982

8 replications x 8 varieties, RCB
1-row plots, 37 ft. long

Planted: April 30, 1982
Harvested: October 20, 1982

Variety	Description[1/]	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose %	Beets/ 100' Number	Root Rot %
E137HL2	0755aa x F80-37	10,931	33.10	16.52	138	0.3
E137HL31	8755aa x F80-37	10,740	32.54	16.49	139	0.5
E137HL33	6755aa x F80-37	10,679	32.69	16.34	142	0.7
E137HL32	7755aa x F80-37	10,558	32.66	16.18	134	0.3
E137HL46	1755aa x F80-37	10,164	31.86	15.96	131	0.0
E137HL35	4755aa x F80-37	10,127	31.45	16.11	133	0.0
E137HL36	3755aa x F80-37	10,041	31.70	15.81	135	0.3
E137H8	F78-546H3 x F80-37	9,893	30.39	16.29	140	0.0
Mean		10,391	32.05	16.21	137	0.3
LSD (.05)		559	1.61	0.43	NS	NS
C. V. (%)		5.4	5.0	2.6	6.8	264.3
F value		3.7**	2.4*	2.7*	1.5 NS	1.2 NS

1/ See footnote for test 382-1.

TEST 1382. EVALUATION OF E137HL45 and E137HL46 TESTCROSSES, 1982

2 replications x 16 entries x 4 locations1/
1-row plots

Variety	Description2/	Acre Yield Sugar	Acre Yield Beets	Sucrose
		Pounds	Tons	Percent
E137HL2	0755aa x F80-37 (check)	11,067	35.01	15.83
E137HL46-1	1755-1aa x F80-37 (7704)	10,633	33.66	15.89
E137HL46-6	1755-6aa x F80-37 (7757)	10,546	34.77	15.25
E137HL46-5	1755-5aa x F80-37 (7757)	10,458	33.28	15.77
E137HL46-11	1755-11aa x F80-37 (7753)	10,381	33.13	15.70
E137HL46-17	1755-17aa x F80-37 (7716)	10,373	34.69	15.06
E137HL46-16	1755-16aa x F80-37 (7716)	10,288	33.47	15.41
E137HL46-2	1755-2aa x F80-37 (7704)	10,280	33.54	15.35
E137HL46-3	1755-3aa x F80-37 (7734)	10,053	33.24	15.10
E137HL46-8	1755-8aa x F80-37 (9760)	10,030	33.22	15.19
E137HL46-10	1755-10aa x F80-37 (7754)	9,944	32.77	15.22
E137HL46-7	1755-7aa x F80-37 (9760)	9,935	32.28	15.44
E137HL46-13	1755-13aa x F80-37 (9703)	9,906	31.98	15.48
E137HL46-9	1755-9aa x F80-37 (7754)	9,882	32.65	15.13
E137HL46-4	1755-4aa x F80-37 (7734)	9,833	32.42	15.16
E137HL46-14	1755-14aa x F80-37 (9703)	9,504	31.95	14.91
Mean		10,195	33.25	15.37
LSD (.05)		824	2.68	0.56
C. V. (%)		8.1	8.10	3.60
F level for varieties		**	*	**
F level for varieties x locations		NS	NS	NS

1/ Two replications at each of four environments were grown as part of a larger progeny test. Tests 1382-1, 1382-2 and 1382-3 were planted Feb. 2, Feb. 23 and April 30 at Salinas and 1382-4 at Brawley. Diseases ranged from 100% infection at Brawley with lettuce infectious yellows to severe to light BWYV infection at Salinas.

2/ 1755-1 through -17 are F_2 lines that were combined in a composite cross to produce the original 755 population. Eight MM, S^f, CTR inbred lines were crossed with two CTR mm, S^f, aa female lines. The original MM inbreds are listed to the right of the testcross. 0755 is an advanced population (C3 by mass selection) derived from the original 755 population.

The hybrid performance of the individual F_2 lines ranged from 86 to 96% of the population hybrid. That is, in no case did one of the initial components of the population have better performance than the advanced population. Therefore, if would appear that population improvement has been effective at raising the combining ability of this germplasm. In the comparison of the two female sources over the male (MM) sources, there was little difference between female 1 and female 2 at 92 and 91%, respectively, of the yield of the population hybrid. In the comparison of the eight male sources over the two female sources, the hybrids ranged in performance from 88 to 94% of the check. Thus it appears that lines extracted from an advanced 755 population should have a better combination of traits than available from any of the original component lines involved in the composite cross.

TEST 1182-3. EVALUATION OF S_1 FAMILY RECURRENT SELECTION: COMPARISON OF CO:C1:C2
SALINAS, CALIFORNIA, 1982

8 replications x 8 varieties, RCB — Planted: April 30, 1982
2-row plots, 37 ft. long — Harvested: October 19-20, 1982

Population	Description1/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot
		Lbs.	Tons	%	Number	%
1790D	C2 Syn 1, SY by S_1 eval. (aa x A)	8,449	25.80	16.34	133	0.1
1790C	C1 Syn 2, Inc. C1 Syn 1 thru S_1	8,213	26.19	15.69	118	0.4
9790D	C1 Syn 2, Inc. type-O sel. thru S_1 (aa x A)	7,999	25.62	15.61	129	0.3
9790	C2 Syn 1, SY by mass sel. (aa x A)	7,797	23.93	16.30	122	0.1
7790D	C1 Syn 1, SY by S_1 eval. (aa x A)	7,593	24.97	15.21	119	0.3
7790C	CO Syn 1, Random inc. of S_1 (aa x A)	7,264	23.56	15.39	114	0.6
1790E	C1 Syn 1, Low SY from C1 for SY by S_1 (aa x A)	7,073	23.79	14.86	123	0.4
7790H	C1 Syn 1, Low SY by S_1 eval. (aa x A)	6,228	20.28	15.36	108	2.0
Mean		7,577	24.27	15.60	121	0.5
LSD (.05)		549	1.41	0.54	8.6	0.7
C. V. (%)		7.2	5.8	3.5	7.1	132.3
F value		13.6**	14.6**	7.2**	6.8**	6.4**

Note: BWYV and other disease incidence was light.

1/ A S_1 family recurrent selection evaluation within monogerm, self-fertile, random-mating population 790 was initiated in 1974. Two cycles of S_1 evaluation and selection for sugar yield (SY) have been completed. Tests 1182-1, -2, and -3 at Salinas and B482 at Brawley that compared the performance of the various synthetics (populations) per se are summarized. Of particular interest is the direct comparison of the equivalent populations for the CO vs C1 vs C2 for sugar yield. 7790C (= CO Syn 1) was used as the check and is an unselected increase through randomly selected S_1 families. 7790D (= C1 Syn 1) and 1790D (= C2 Syn 1) were produced after 1 and 2 cycles of selection and recombination. 1790C (= C1 Syn 2) was produced from the recombination of random S_1 lines from 7790D (= C1 Syn 1). 7790H (C1 Syn 1) was produced from the S_1 lines with the lowest sugar yield from the original source and 1790E for low sugar yield from the C1 Syn 1 lines 7790D.

When the performance of the populations for the source (CO), the C1's for sugar yield and low sugar yield selections, and the C2 for sugar yield are considered, the results suggest that S_1 evaluation was highly effective at discriminating genotypes that produce higher and lower population performance. For the

TEST 1182-1. EVALUATION OF S_1 FAMILY RECURRENT SELECTION: COMPARISON OF CO:C1:C2
SALINAS, CALIFORNIA, 1982

8 replications x 8 varieties, RCB — Planted: February 2, 1982
2-row plots, 30 ft. long — Harvested: October 4-5, 1982

Population	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot
		Lbs.	Tons	%	Number	%
9790D	C1 Syn 2, Inc. type-O sel. thru S_1 (aa x A)	8,081	26.04	15.55	132	0.0
9790	C2 Syn 1, SY by mass sel. (aa x A)	7,997	25.51	15.68	129	0.0
1790D	C2 Syn 1, SY by S_1 eval. (aa x A)	7,962	25.85	15.41	132	0.0
7790D	C1 Syn 1, SY by S_1 eval. (aa x A)	7,855	25.82	15.22	130	0.3
1790C	C1 Syn 2, Inc. C1 Syn 1 thru S_1	7,790	25.34	15.37	132	0.2
1790E	C1 Syn 1, Low SY from C1 for SY by S_1 (aa x A)	7,431	24.78	14.99	127	0.5
7790C	CO Syn 1, Random inc. of S_1 (aa x A)	7,056	23.06	15.29	125	0.2
7790H	C1 Syn 1, Low SY by S_1 eval. (aa x A)	6,894	22.45	15.36	125	0.9
Mean		7,633	24.86	15.36	129	0.3
LSD (.05)		516	1.64	0.37	NS	0.5
C. V. (%)		6.7	6.6	2.4	5.4	205.3
F value		6.2**	5.6**	2.5*	1.5 NS	2.7*

Note: BWYV infection was severe.

1/ (Continued) Salinas tests, the mean relative values for the C1 (low SY), CO, C1 (SY), and C2 (SY) were 93, 100, 109, and 115%, respectively. The low SY selection from 9790D (C1 Syn 1 for SY) caused a return in performance to very near the level of the original source, 7790C. The reasons for the favorably improved performance of the C1 Syn 2 populations (1790C and 9790D) are open to speculation. In these cases, a second cycle of recombination appears to have improved the performance over the initial C1 Syn 1 source. These results suggest that comparisons probably should be made only within equivalent synthetics and that recombination beyond the Syn 1 generation may improve performance. S_1 evaluation and selection are theoretically supposed to improve traits conditioned by additive genetic variance, but within the 790 source, the populations have mostly been improved for root yield and not for % sucrose. The results of tests 1182-1, -2, and -3 suggest that the improvement in this population by S_1 evaluation was probably not due to improved host-plant resistance but due to improvement in yield factors per se. Of the tests at Salinas, the greatest response to selection was measured in the trial with the least disease incidence (1182-3). The hybrid performance of these populations and the potential of S_1 selection per se to modify combining ability are under investigation.

TEST 1182-2. EVALUATION OF S_1 FAMILY RECURRENT SELECTION: COMPARISON OF CO:C1:C2
SALINAS, CALIFORNIA, 1982

8 replications x 8 varieties, RCB
2-row plots, 30 ft. long

Planted: February 23, 1982
Harvested: October 7, 1982

Population	Description	Acre Yield Sugar Lbs.	Acre Yield Beets Tons	Sucrose %	Beets/ 100' Number	Root Rot %
1790D	C2 Syn 1, SY by S_1 eval. (aa x A)	9,307	31.73	14.67	139	0.5
9790D	C1 Syn 2, Inc. type-O sel. thru S_1 (aa x A)	9,306	31.54	14.73	138	0.5
1790C	C1 Syn 2, Inc. C1 Syn 1 thru S_1	9,107	30.83	14.76	133	0.6
7790D	C1 Syn 1, SY by S_1 eval. (aa x A)	8,984	31.42	14.32	134	0.2
1790E	C1 Syn 1, Low SY from C1 for SY by S_1 (aa x A)	8,284	29.39	14.07	136	1.1
9790	C2 Syn 1, SY by mass sel. (aa x A)	8,160	28.40	14.38	131	0.3
7790C	CO Syn 1, Random inc. of S_1 (aa x A)	8,042	27.69	14.52	127	1.0
7790H	C1 Syn 1, Low SY by S_1 eval. (aa x A)	7,759	26.05	14.90	129	1.6
Mean		8,619	29.63	14.54	133	0.71
LSD (.05)		548	1.63	NS	NS	NS
C. V. (%)		6.3	5.5	4.4	7.0	161.2
F value		10.4**	13.4**	1.4 NS	1.8 NS	1.4 NS

Note: BWYV infection was moderate.

TEST 1082-1. EFFECTS OF MASS SELECTION ON GCA, SALINAS, CALIFORNIA, 1982

8 replications x 8 varieties, RCB
2-row plots, 30 ft. long

Planted: February 2, 1982
Harvested: October 15, 1982

Variety	Description[1/]	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/100' Number	Root Rot Percent	Bolting Percent
Y023H8	F78-546H3 x Y923	10,030	32.03	15.68	122	2.0	0.0
915H8	F70-546H3 x 915	9,502	30.93	15.35	143	0.6	0.0
Y030H8	F78-546H3 x Y930	10,085	32.90	15.34	129	0.2	0.0
968H8	F70-546H3 x 468	9,299	31.19	14.94	132	0.5	0.2
Y026H8	F78-546H3 x Y926	10,337	31.85	16.25	130	0.6	0.0
959H8	F70-546H3 x 959	9,884	32.61	15.16	134	0.7	0.0
E037H8	F78-546H3 x E937	10,591	34.33	15.41	132	0.2	0.0
Y009H8	F78-546H3 x US 22/3	9,139	30.05	15.27	131	0.6	4.9
Mean		9,858	31.99	15.42	132	0.7	0.6
LSD (.05)		629	2.05	0.41	NS	NS	0.9
C. V. (%)		6.4	6.4	2.6	9.0	163.6	144.5
F value		5.3**	3.4**	7.5**	1.8 NS	2.1 NS	28.0**

1/ 915 = Inc. US 15. Y923 = C_4 US 15. 468 = US 75. Y930 = C_5 US 75. 959 = Inc. US 56/2. Y926 = C_4 US 56/2. E937 = C_{11} US 75. Mass selection was for resistance to virus yellows and/or erwinia root rot but sugar yield on an individual plant basis was the primary selection criterion.

Note: A high incidence of virus yellows (BWYV) occurred in the February 2 planted trials and probably influenced yield differentially. The hybrids with the highest resistance to yellows would have had an advantage. The differences in ranking between tests 1082-1 and 1082-2 in 1982 and 1281 (page A39, 1981 Report) in 1981 are probably primarily due to the differential influences of yellows infection. Thus, for this test, between pairs of entries, e.g., Y023H8 and 915H8, the differences in performance would be due to both differences in GCA and yellows resistance.

TEST 1082-2. EFFECTS OF MASS SELECTION ON GCA, SALINAS, CALIFORNIA, 1982

8 replications x 8 varieties, RCB
2-row plots, 30 ft. long

Planted: February 23, 1982
Harvested: October 7-8, 1982

Variety	Description[1/]	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/100' Number	Root Rot Percent	Bolting Percent
Y023H8	F78-546H3 x Y923	11,400	38.49	14.82	132	0.3	0.0
915H8	F70-546H3 x 915	10,388	35.86	14.53	139	0.3	0.0
Y030H8	F78-546H3 x Y930	10,661	36.69	14.54	131	0.0	0.0
968H8	F70-546H3 x 468	10,095	36.02	14.06	131	0.5	0.0
Y026H8	F78-546H3 x Y926	11,084	36.16	15.38	134	0.2	0.0
959H8	F70-546H3 x 959	10,851	37.88	14.35	132	0.6	0.0
E037H8	F78-546H3 x E937	11,050	37.93	14.61	140	0.3	0.0
Y009H8	F78-546H3 x US 22/3	9,544	33.00	14.53	135	0.5	2.6
Mean		10,634	36.50	14.60	134	0.3	0.3
LSD (.05)		1,056	3.27	0.62	NS	NS	0.9
C. V. (%)		9.9	8.9	4.2	6.7	210.1	264.3
F value		2.6*	2.3*	3.1**	1.3 NS	0.6 NS	9.2**

1/ 915 = Inc. US 15. Y923 = C_4 US 15. 468 = US 75. Y930 = C_5 US 75. 959 = Inc. US 56/2. Y926 = C_4 US 56/2. E937 = C_{11} US 75. Mass selection was for resistance to virus yellows and/or erwinia root rot but sugar yield on an individual plant basis was the primary selection criterion.

Note: A low incidence of virus yellows (BWYV) occurred in the February 23 planted trials but was considerably less severe than for the February 2 planted trials. No other disease problems occurred.

TEST 1682-SULFUR CONTROL. PERFORMANCE AND POWDERY MILDEW RESISTANCE EVALUATION OF ADVANCED GERMPLASM, SALINAS, CALIFORNIA, 1982

Split-block with 8 replications
16 varieties x 2 powdery mildew treatments
1-row plots, 30 ft. long

Planted: February 24, 1982
Sulfured1/: 7/13, 8/16, 9/7
Harvested: October 13-14, 1982

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'2/	Root Rot2/	Non Sucrose SS	RJAP	PM Score3/ 7/22	PM Score3/ 8/14	PM Score3/ 9/6
		Pounds	Tons	%	Number	%	%	%			
Y139	YR-ER Y039	12,864	41.07	15.65	137	0.2	3.02	83.8	1.1	0.1	0.0
Y131(C31/4)	YR-ER Y031	12,518	42.93	14.58	142	2.0	2.98	83.0	1.0	0.5	0.5
Y147	YR-ER Y947	12,513	42.80	14.61	138	0.3	2.78	84.0	2.5	0.8	0.4
Y141	YR-ER Y041	12,382	42.76	14.46	135	0.6	2.83	83.6	0.8	0.4	0.3
Y152	F_2(C37 x Y41)	12,302	43.36	14.19	135	1.2	2.78	83.6	2.0	0.9	0.5
HH27	Holly Hybrid	12,162	41.84	14.53	144	0.1	2.64	84.6	1.0	0.3	0.1
Y148	YR-ER Y948	11,938	42.15	14.18	138	0.0	2.86	83.2	2.4	0.8	0.5
Y149	Inc. F_2(C37 x C31/4)	11,779	43.40	13.57	137	0.8	2.96	82.1	1.8	0.6	0.1
0755H72	C718HO x 9755	11,675	42.51	13.74	135	0.9	2.61	84.0	2.5	0.6	0.4
1546H72	C718HO x C546	11,435	40.88	13.99	144	0.0	2.61	84.3	3.0	0.8	0.6
1546HL5	C301CMS x C546	11,384	40.51	14.04	140	0.4	2.78	83.4	2.3	1.0	0.6
Y146 (C46)	YR-ER Y046	11,278	38.56	14.61	142	0.0	2.82	83.8	0.5	0.0	0.0
964	Inc. 364 (C64)	10,620	40.41	13.12	130	0.7	2.83	82.3	1.1	0.6	0.0
F81-546H3	C562CMS x C546 (81327)	10,434	36.64	14.21	142	0.7	2.76	83.7	2.3	1.4	0.5
F81-37	Inc. F80-37 (81101)	10,082	34.66	14.53	145	0.3	2.91	83.3	2.6	1.9	0.5
1755	YR-ER 9755	10,018	35.40	14.14	145	0.0	3.03	82.3	1.4	0.0	0.1
Mean		11,586	40.62	14.26	139	0.5	2.83	83.5	1.8	0.7	0.3
LSD (.05)		855	2.66	0.49	5.5	0.8	0.24	1.2	--	--	--
C. V. (%)		7.4	6.6	3.4	6.0	229.8	8.7	1.5	--	--	--
F value		8.7**	8.9**	10.3**	4.9**	3.3**	2.4**	2.8**	--	--	--

1/ Performance and % loss data for noncontrolled treatment are summarized on the following page. Wettable sulfur applied at about 10 lbs per acre on 7/13, 8/16, and 9/7/82.
2/ Over both treatments.
3/ PM scored on a scale from 0 to 9.

Note: Natural infection with BWYV was moderate.

TEST 1682-NO MILDEW CONTROL. PERFORMANCE AND POWDERY MILDEW RESISTANCE EVALUATION
OF ADVANCED GERMPLASM, SALINAS, CALIFORNIA, 1982

Split-block with 8 replications
16 varieties x 2 powdery mildew treatments
1-row plots, 30 ft. long

Planted: February 24, 1982
PM not controlled
Harvested: October 13-14, 1982

Variety	Description	Sugar Yield Mildew	Sugar Yield Loss	Beet Yield Mildew	Beet Yield Loss	Sucrose Mildew	Sucrose Loss	Non Sucrose SS	RJAP	PM Score 3/ 7/22	PM Score 3/ 8/14	PM Score 3/ 9/6
		Lbs/A	%	Tons/A	%	%	%	%	%	7/22	8/14	9/6
Y139	YR-ER Y039	12,534	2.4	40.51	1.2	15.47	1.1	3.13	83.2	2.4	3.3	3.6
Y131(C31/4)	YR-ER Y031	12,176	2.5	41.82	2.4	14.57	0.1	3.02	82.8	2.9	5.1	4.8
HH27	Holly Hybrid	12,063	0.7	41.05	1.9	14.68	-1.2	2.64	84.7	1.6	2.6	3.1
Y147	YR-ER Y947	11,998	3.6	40.67	4.6	14.73	-1.1	2.79	84.1	2.9	5.3	4.4
Y141	YR-ER Y041	11,858	3.7	40.53	4.9	14.61	-1.1	2.89	83.5	1.5	2.1	2.4
Y152	F_2(C37 x Y41)	11,448	6.9	39.84	8.1	14.36	-1.2	2.88	83.3	3.8	5.0	5.4
Y146 (C46)	YR-ER Y046	11,346	-0.9	38.72	-0.5	14.62	-0.2	2.89	83.5	2.3	3.0	3.1
Y148	YR-ER Y948	11,231	5.8	40.19	4.6	13.98	1.3	2.80	83.3	3.3	5.1	4.3
964	Inc. 364 (C64)	10,670	-1.3	40.65	-0.8	13.13	-0.3	2.69	83.0	1.9	4.4	4.5
0755H72	C718HO x 9755	10,619	8.6	39.20	7.4	13.56	1.3	2.70	83.4	4.0	5.6	5.8
Y149	F_2(C37 x C31/2)	10,541	10.6	38.43	11.6	13.69	-1.0	2.84	82.8	3.9	5.4	5.3
1546HL5	C301CMS x C546	10,506	7.8	38.15	5.7	13.71	2.3	2.69	83.6	3.3	6.6	6.0
1546H72	C718HO x C546	10,254	10.4	37.82	7.4	13.54	3.2	2.77	83.0	4.0	6.9	6.5
1755	YR-ER 9755	9,713	2.9	34.33	2.9	14.16	-0.1	3.06	82.2	2.3	3.3	3.0
F81-546H3	C562CMS x C546(81327)	8,697	16.1	32.42	11.2	13.39	5.6	2.77	82.8	3.4	6.6	6.9
F81-37	Inc. F80-37 (81101)	8,520	15.5	29.99	13.5	14.17	2.5	2.96	82.7	4.8	6.6	6.3
Mean		10,886	6.0	38.39	5.4	14.15	0.7	2.85	83.2	3.0	4.8	4.7
LSD (.05)		751	7.0	2.54	5.8	0.44	4.0	0.23	1.14	0.7	0.9	0.8
C. V. (%)		7.0	119.1	6.7	108.7	3.1	585.2	8.00	1.4	23.6	18.7	16.1
F value for varieties		19.7**	4.4**	13.6**	4.2**	16.0*	1.8*	3.1**	2.1*	14.5**	23.8**	26.7**
F value for mildew treatments		11.8*	--	20.6**	--	0.8NS	--	0.2NS	0.6NS			
F value for varieties x mildew		3.2**	--	3.4**	--	1.8*	--	0.6NS	1.0NS			

TEST 2182-NONINOCULATED. YELLOWS AND PERFORMANCE EVALUATION OF O.P. SOURCES AND THEIR ADVANCED POPULATIONS, SALINAS, CALIFORNIA, 1982

Split-block with 8 replications
8 varieties and 2 virus treatments
1-row plots, 37 ft. long

Planted: April 30, 1982
Noninoculated1/
Harvested: November 15, 1982

Variety2/	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot
		Pounds	Tons	Percent	Number	Percent
Y023	Inc. Y923	8,842	26.67	16.59	99	0.5
915	Inc. 915	9,331	28.08	16.61	109	0.6
Y030	Inc. Y930	8,122	24.34	16.70	114	0.3
968	Inc. 468	8,943	27.07	16.53	116	0.0
Y026	Inc. Y926	8,651	24.37	17.78	111	0.0
959	Inc. 959	8,743	26.52	16.54	117	0.6
F81-37	Inc. F80-37	8,718	26.03	16.82	133	0.0
Y009	Inc. US 22/3	8,286	24.66	16.83	113	1.3
Mean		8,705	25.97	16.80	114	0.4
LSD (.05)		574	1.57	0.46	11.8	NS
C. V. (%)		6.5	6.0	2.7	10.2	289.7
F value		3.5**	6.4**	6.6**	5.2**	1.2 NS

1/ The BWYV inoculated performance and % loss data are summarized on the following page.

2/ 915 = Inc. US 15. Y023 = C_4 US 15. 968 = Inc. US 75. Y030 = C_5 US 75. 959 = Inc. US 56/2. Y026 = C_4 US 56/2. F81-37 = C_{11} US 75. Selection was for resistance to virus yellows but sugar yield was the primary selection criterion.

TEST 2182-BWYV INOCULATED. YELLOWS AND PERFORMANCE EVALUATION OF O.P. SOURCES AND THEIR ADVANCED POPULATIONS, SALINAS, CALIFORNIA, 1982

Split-block with 8 replications
8 varieties and 2 virus treatments
1-row plots, 37 ft. long

Planted: April 30, 1982
BWYV Inoculated: June 22, 1982
Harvested: November 15, 1982

Variety2/	Description	Sugar Yield Inoc.	Sugar Yield Loss	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Beets/ 100'	Root Rot	Virus Yellows Score	Virus Yellows Score
		Lbs/A	%	T/A	%	%	%	Number	%	8/21	9/13
Y023	Inc. Y923	6,013	32.2	19.29	28.2	15.61	5.9	101	0.6	6.4	6.3
915	Inc. 915	4,934	46.1	16.92	39.2	14.61	12.0	117	1.2	7.6	7.8
Y030	Inc. Y930	6,092	25.0	19.54	19.8	15.61	6.5	109	0.5	4.8	4.8
968	Inc. 468	5,633	36.6	18.72	30.5	15.07	8.8	113	0.6	6.3	7.1
Y026	Inc. Y926	7,429	13.6	21.69	10.4	17.16	3.5	117	0.0	4.6	5.5
959	Inc. 959	5,726	34.7	18.57	30.2	15.43	6.7	115	0.0	6.5	6.8
F81-37	Inc. F80-37	7,196	17.8	22.16	15.3	16.34	2.9	131	0.0	2.3	3.1
Y009	Inc. US 22/3	5,540	31.7	17.62	27.3	15.73	6.4	109	0.4	6.4	6.4
Mean		6,070	29.7	19.31	25.1	15.69	6.6	114	0.4	5.6	6.0
LSD (.05)		685	7.2	2.01	6.7	0.43	3.5	11.7	NS	0.7	0.8
C. V. (%)		11.2	24.0	10.3	26.3	2.7	52.0	10.2	286.1	12.4	12.5
F value for varieties		12.4**	17.4**	6.7**	15.9**	26.6**	5.7**	4.3**	1.0 NS	46.3**	31.1**
F value for trtmts.		82.2**		75.1**		158.9**		0.0 NS	0.0 NS		
F value for variety x trtmts.		12.3**		12.7**		5.6**		0.8 NS	1.1 NS		

2/ See test 2182-Noninoculated.

TEST 2282-NONINOCULATED. YELLOWS AND PERFORMANCE EVALUATION OF GERMPLASM
SALINAS, CALIFORNIA, 1982

Split-block with 8 replications
16 varieties x 2 virus treatments
1-row plots, 37 ft. long

Planted: April 30, 1982
Noninoculated
Harvested: November 2-3, 1982

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'2/	Root Rot2/	Non Sucrose SS	Raw J. App. Pur.	Extract. Sugar
		Lbs.	Tons	%	Number	%	%	%	Lbs./T
Y052HL18	9747-1,2,3aa x Y952	10,695	32.12	16.69	107	0.8	2.80	85.7	286
Y146 (C46)	YR-ER Y046	10,364	31.45	16.53	120	0.0	3.09	84.3	279
Y152	F_2(C37 x Y41)	10,338	30.93	16.78	110	0.5	2.99	84.9	285
Y139	YR-ER Y039	10,283	29.24	17.63	114	0.0	3.16	84.8	299
Y131 (C31/4)	YR-ER Y031	10,235	31.13	16.52	114	0.6	2.84	85.3	282
Y149	F_2(C37 x C31/2)	9,915	30.72	16.19	114	0.0	2.82	85.2	276
Y141	YR-ER Y041	9,777	29.23	16.74	111	0.0	2.95	85.0	285
Y049HL18	9747-1,2,3aa x Y949	9,582	30.68	15.71	102	0.9	2.67	85.4	269
1747	YR-ER 0747	9,508	29.87	15.96	119	0.2	2.88	84.7	270
1748	YR-ER 0748	9,117	29.40	15.55	121	0.6	2.77	84.9	264
968	Inc. 468 (US 75)	9,015	28.44	15.87	123	0.3	3.05	83.9	266
F81-37	Inc. F80-37 (81101)	8,796	26.43	16.69	125	0.0	3.01	84.7	283
SP6822-0	6519 (Rec'd. 2/1/80)	8,557	27.16	15.82	108	0.3	2.72	85.3	270
1755	YR-ER 9755	8,193	25.88	15.86	131	0.0	2.84	84.8	269
F81-546H3	562CMS x 546 (81327)	7,777	25.06	15.61	129	0.0	2.80	84.7	265
1796	0796-1,2aa x A	7,481	24.69	15.21	115	0.4	2.74	84.7	258
Mean		9,352	28.90	16.21	117	0.3	2.88	84.9	275
LSD (.05)		724	2.07	0.49	8	0.6	0.24	NS	9.2
C. V. (%)		7.8	7.2	3.1	8.8	326.4	8.3	1.2	3.4
F value		14.5**	10.3**	12.4**	7.5**	1.9*	2.8**	1.4 NS	10.8**

1/ The BWYV inoculated performance and loss data are summarized on the following page.
2/ Over both treatments.

TEST 2282-BWYV INOCULATED. YELLOWS AND PERFORMANCE EVALUATION OF GERMPLASM
SALINAS, CALIFORNIA, 1982

Split-block with 8 replications
16 varieties x 2 virus treatments
1-row plots, 37 ft. long

Planted: April 30, 1982
BWYV Inoculated: June 22, 1982
Harvested: November 2-3, 1982

Variety	Description	Sugar Yield Inoc.	Sugar Yield Loss	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Non-Suc. SS	Extract. Sugar	RJAP	Yellows Scores 3/ 8/21	Yellows Scores 3/ 9/13
		Lbs/A	%	T/A	%	%	%	%	Lbs/T	%		
Y152	F_2(C37 x Y41)	9,226	10.7	28.12	8.8	16.41	2.1	3.02	277	84.5	3.5	4.6
Y141	YR-ER Y041	9,069	6.9	27.33	6.1	16.60	0.8	3.07	280	84.4	4.4	5.0
Y149	F_2(C37 x C31/4)	9,010	8.0	28.49	7.0	15.87	1.9	2.83	269	84.9	4.0	5.1
Y139	YR-ER Y039	8,988	12.5	26.19	10.4	17.20	2.4	3.06	292	84.9	4.0	6.0
Y131(C31/4)	YR-ER Y031	8,961	12.2	28.44	7.9	15.78	4.4	2.95	266	84.3	4.6	5.0
Y146(C46)	YR-ER Y046	8,891	14.0	27.57	12.0	16.15	2.3	2.88	274	84.9	3.9	4.6
Y052HL18	9747-1,2,3aa x Y952	8,593	19.4	26.68	16.7	16.13	3.2	2.93	273	84.6	3.9	4.9
Y049HL18	9747-1,2,3aa x Y949	8,491	11.3	27.95	8.8	15.24	2.9	2.68	259	85.0	4.1	4.9
F81-37	Inc. F80-37 (81101)	7,998	8.8	24.70	5.9	16.21	2.9	3.21	271	83.4	3.0	4.3
1747	YR-ER 0747	7,995	15.9	26.34	11.7	15.19	4.9	2.77	257	84.6	3.4	4.0
1748	YR-ER 0748	7,754	14.9	25.79	12.2	15.05	3.1	2.71	255	84.7	3.9	4.8
1755	YR-ER 9755	6,959	13.5	22.56	11.5	15.48	2.3	2.97	260	83.9	6.3	5.6
968	Inc. 468 (US 75)	6,888	21.9	23.01	17.6	14.98	5.6	2.93	251	83.7	6.4	7.5
1796	0796-1,2aa x A	6,432	13.1	22.32	8.4	14.44	5.0	2.59	245	84.8	4.6	4.8
F81-546H3	562CMS x 546 (81327)	5,655	27.0	19.81	20.7	14.36	7.9	2.61	243	84.6	7.1	7.6
SP6822-0	6519 (Rec'd. 2/1/80)	4,716	44.7	16.33	39.7	14.41	8.6	2.78	242	83.8	8.0	8.6
Mean		7,852	16.0	25.10	12.8	15.59	3.8	2.87	263	84.4	4.7	5.5
LSD (.05)		644	7.7	1.87	7.0	0.52	3.0	0.21	9.9	1.0	0.6	0.8
C. V. (%)		8.3	48.9	7.50	55.0	3.40	80.2	7.3	3.8	1.2	13.5	14.0
F value for varieties		35.0**	11.2**	26.9**	11.1**	20.4**	4.1**	5.7**	16.6**	1.9*	41.9**	24.3**
F value for virus		47.2**		27.6**		43.3**		NS	44.9**	4.2 NS		
F value for variety x virus		8.0**		8.9**		3.8**		1.7 NS	3.8**	1.7 NS		

3/ Yellows symptoms scored from 0 to 9 (0 = green).

TEST 2382-NONINOCULATED. YELLOWS AND PERFORMANCE EVALUATION OF USDA AND COMPANY HYBRIDS
SALINAS, CALIFORNIA, 1982

Split-block with 8 replications
16 varieties x 2 virus treatments
1-row plots, 37 ft. long

Planted: May 1, 1982
Noninoculated1/
Harvested: November 4-5, 1982

Variety	Description2/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'3/	Root Rot3/	Non Sucrose SS	Raw J. App. Pur.	Extract. Sugar
		Lbs.	Tons	%	Number	%	%	%	Lbs./T
BJ19	Bush-Johnsons (1/82)	11,036	30.10	18.36	126	1.3	2.71	87.1	320
E137HL2	0755aa x F80-37	10,801	32.34	16.72	124	0.0	2.59	86.6	290
E137HL29	0546H72 x F80-37	10,422	31.66	16.51	126	0.3	2.61	86.4	285
0G5545	Betaseed (1/82)	10,348	32.09	16.14	122	0.1	2.56	86.3	279
NK53091	Hilleshog (4/82)	10,310	29.79	17.32	128	0.0	2.74	86.3	299
H81180	SS-C42 Hybrid (4/82)	10,256	31.15	16.56	130	0.4	2.63	86.3	286
E0206	Amalgamated (1/82)	10,245	30.78	16.66	132	0.0	2.88	85.3	284
SS-Y1	Spreckels (4/82)	10,241	31.40	16.31	126	0.5	2.58	86.4	282
EM1	Mennesson (4/82)	10,133	30.22	16.77	125	1.4	2.50	87.0	292
1459-04	Holly (12/9/81)	10,069	30.41	16.57	116	0.3	2.77	85.7	284
1757HL9	0747aa x 0755	9,991	31.33	15.98	119	0.0	2.54	86.3	276
Y131H8	546H3 x Y031 (C31/2)	9,876	30.21	16.37	121	0.2	2.63	86.2	282
ACS 79-54	Amer. Crystal (2/82)	9,872	29.64	16.64	125	1.0	2.50	86.9	289
Y146H8	546H3 x Y046	9,758	29.21	16.74	124	0.3	2.73	86.0	288
U137H8	Union (81060)	9,642	29.65	16.31	124	0.0	2.72	85.7	280
US H11	546H3 x C36 (80096)	9,564	29.67	16.17	125	0.0	2.61	86.1	278
Mean		10,160	30.60	16.63	125	0.4	2.64	86.3	287
LSD (.05)		804	NS	0.49	7	0.8	NS	1.0	9.8
C. V. (%)		8.0	7.4	3.0	6.2	281.0	8.6	1.2	3.4
F value		1.9*	1.5 NS	10.1**	2.5**	2.7**	1.8 NS	1.9*	9.2**

1/ The BWYV inoculated performance and loss data are summarized on the following page.
2/ 0546H72 = C718CMS x C546. 546H3 = C562CMS x C546.
3/ Over both treatments.

TEST 2382-BWYV INOCULATED. YELLOWS AND PERFORMANCE EVALUATION OF USDA AND COMPANY HYBRIDS
SALINAS, CALIFORNIA, 1982

Split-block with 8 replications
16 varieties x 2 virus treatments
1-row plots, 37 ft. long

Planted: May 1, 1982
BWYV Inoculated: June 22, 1982
Harvested: November 4-5, 1982

Variety	Description	Sugar Yield Inoc.	Sugar Yield Loss	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Non-Suc. SS	Raw J. App. Pur.	Extract. Sugar	Yellows Scores 4/ 8/21	Yellows Scores 4/ 9/13
		Lbs/A	%	T/A	%	%	%	%	%	Lbs/T		
E137HL2	0755aa x F80-37	9,415	12.1	29.59	8.0	15.93	4.7	2.77	85.2	272	4.5	4.6
E0206	Amalgamated (1/82)	9,229	9.2	28.88	5.6	15.99	4.0	2.90	84.7	271	3.8	4.1
E137HL29	0546H72 x F80-37	8,755	15.4	28.77	8.4	15.26	7.6	2.50	85.9	262	3.9	4.4
Y146H8	546H3 x Y046	8,540	11.6	26.79	7.5	15.99	4.5	2.79	85.1	272	5.5	5.3
H81180	SS-C42 Hybrid (4/82)	8,415	17.4	27.63	10.7	15.32	7.4	2.54	85.7	263	5.6	5.0
1757HL9	0747aa x 0755	8,377	14.5	27.70	10.0	15.16	5.1	2.64	85.1	258	4.8	4.1
1459-04	Holly (12/9/81)	8,373	16.2	26.66	11.9	15.74	5.0	2.54	86.1	271	5.5	6.1
Y131H8	546H3 x Y031 (C31/2)	8,354	14.3	27.08	9.3	15.47	5.5	2.70	85.1	263	5.4	5.3
U137H8	Union (81060)	8,285	13.8	26.94	8.9	15.39	5.6	2.68	85.2	262	4.1	4.8
OG5545	Betaseed (1/82)	8,277	19.9	27.29	14.8	15.17	6.0	2.66	85.1	258	5.8	6.5
US H11	546H3 x C36 (80096)	8,197	13.8	27.27	7.8	15.07	6.6	2.47	85.9	259	5.6	5.0
NK53091	Hilleshog (4/82)	8,154	19.8	25.62	12.9	15.94	8.0	2.70	85.5	273	5.3	6.0
SS-Y1	Spreckels (4/82)	8,089	20.6	26.47	15.5	15.31	6.1	2.66	85.2	261	5.6	4.6
EM1	Mennesson (4/82)	7,570	24.8	24.38	19.0	15.53	7.4	2.68	85.3	265	7.1	8.0
ACS 79-54	Amer. Crystal (2/82)	7,017	28.0	23.19	21.1	15.13	9.1	2.51	85.7	260	7.4	7.1
BJ19	Bush-Johnsons (1/82)	6,992	36.2	21.61	28.0	16.24	11.5	2.74	85.5	278	7.6	8.1
Mean		8,252	18.0	26.62	12.5	15.54	6.5	2.65	85.4	266	5.5	5.6
LSD (.05)		698	7.7	2.08	6.9	0.42	2.9	0.23	NS	8.9	0.8	0.7
C. V. (%)		8.5	43.2	7.9	55.9	2.7	44.8	8.8	1.3	3.4	14.9	13.3
F value for varieties		6.8**	6.4**	7.9**	5.9**	6.3**	3.6**	2.0*	1.0 NS	3.9**	16.1**	24.4**
F value for virus		42.9**		22.7**		194.2**		0.1 NS	14.8**	167.0**		
F value for variety x virus		6.1**		5.0**		4.2**		1.1 NS	1.3 NS	3.9**		

4/ Yellows symptoms scored from 0 to 9 (0 = green).

VARIETY TRIALS, BRAWLEY, CALIFORNIA, 1981-82

Location: USDA-ARS, Imperial Valley Conservation Research Center

Soil type: Holtville silty clay loam

Previous crops: 1980 and 1981, cereals; 1979, sugarbeets

Fertilization: On 2.6 acres, 480 lbs 46:0:0 and 450 lbs 11:48:0 preplant

Summary: 1981-1982 Tests, Brawley, California

Test No.	Seeding Date 1981[1/]	Entries per Test	No. Reps.	Rows per Plot[2/]	Plot Length Ft.	1982 Harvest Date	Test Design
B182	9/3	16	8	2	24	5/21	RCB
B282	"	16	8	2	"	5/20	RCB
B382	"	8	8	1	"	5/19	RCB
B482	"	8	8	2	"	5/22	RCB
B582	"	8	8	1	"	5/19	RCB
B682	"	8	8	1	"	5/19	RCB
B982-4	"	96	1	1	"	5/24	3/
B1382-4	"	16	2	1	"	5/24	RCB
B882	"	6	5	2	"	5/24	RCB
Obs-1	"	16	2	1	"	Observation	Test
Obs-2	"	32	2	1	"	"	"

1/ Watered 9/4-8/82 by sprinkler.
2/ Rows 32" wide.
3/ Progeny test in incomplete blocks (location 4).

Irrigations: Sprinkled as needed to establish stands. Then furrow irrigated on 10/6, 10/22, 11/23, 12/?, 1/20, 3/1, 4/7, and 4/22.

Thinned: Late September 1981.

Herbicide: 10/6/81, 3 pts/A Eptam 7E through irrigation water.

Diseases and insects: 10/28, 9/24, 10/5 Methomyl at 0.5, 0.67, and 0.67 lbs/A for armyworms and loopers. 2/3/82 and 2/25/82 with sulfur at 40 lbs/A for powdery mildew control. Bolting was extremely light. No root rot occurred. A previously unrecognized virus disease, "Lettuce infectious yellows" occurred. 100% of all varieties were infected. LIY is vectored by the sweet potato whitefly, *Bemisia tabaci*, which occurred in extremely high populations in the fall of 1981. Probably 100% of all sugarbeets were infected in the I.V. in 1981-2. Sugar yields were probably reduced at least 25% with reductions in root yield, % sucrose, and purity occurring and increased root tare. No immunity or high resistance was obvious in these plots but variability for damage was suspected, particularly in the progeny test (B982-4).

Harvest and sugar analyses: Plots were dug with Holly's spike wheel lifter and sugar analyses made by Holly's tare lab. Two samples per plot were run except for tests B382, B582, and B682 in which only one sample per plot was run.

Remarks: Stands were good and reliability under LIY conditions should be good for all tests except B382, B582, and B682. The latter three tests had more variable stands and probably only moderate reliability.

We wish to acknowledge J. Robertson and C. Brown, I. V. Conservation Research Center, for plot supervision and cultural practices.

Progeny test of 755 S_1 testcrosses: In a test of 84 testcrosses of 755 S_1 lines topcrossed with C37, there was a strong suggestion of genetic variability (differential reaction) to LIY (even though all plants in all lines were obviously infected). The usual negative correlation between root yield and sucrose content was not observed. In some cases, testcrosses with the highest root weight also had high sucrose and vice versa. Progenies with the lowest root weight were badly shaped, had greater feeder root proliferation with greater than usual quantities of attached soil. Frequently within these progenies, roots showed a constricted zone about 2/3 of the way down the root. When this area of the root was sectioned, the tissue had very dark vascular rings and a general tan to grey appearance. The general impression was that based upon these traits that a criterion of mass selection based upon root size, sucrose %, shape, tare, etc., would effectively identify the most resistant genotypes. On the basis of the above testcross performances, S_1 lines produced from remnant seed will be recombined in 1983 to form synthetics for high and low sugar yield performance. The comparative performanceof these divergent C1 Syn 1 populations under LIY conditions should provide additional evidence on the occurrence of genetic variability and its heritability.

TEST B182. IMPERIAL VALLEY 546H3 X POLLINATOR HYBRID TEST, 1981-82

16 varieties, 8 replications, RCB
2-row plots, 24 ft. long

Planted: September 3, 1981
Harvested: May 21, 1982

Variety	Description[1/]	Acre Yield[2/] Sugar	Acre Yield[2/] Beets	Sucrose	Bolting	Beets/ 100'	Clean Beets	Nitrate Nitrogen
		Pounds	Tons	Percent	Percent	Number	Percent	Rating
E137H4	F67-563HO x F80-37	9,735	29.22	16.67	0.2	148	94.1	2.3
E137HL6	0755-29aa x F80-37	9,286	28.17	16.48	0.0	153	93.5	1.9
E137HL1	0755HO x F80-37	8,487	26.07	16.29	0.0	151	91.7	2.6
E137H6	F80-566CMS x F80-37	8,152	25.14	16.24	0.0	157	93.9	2.1
Y146HL1	0755HO x Y046	7,860	24.86	15.85	0.0	148	92.7	2.3
E137H8	546H3 x F80-37	7,848	24.06	16.33	0.2	155	92.2	2.3
U137H8	546H3 x F80-37 (81060)	7,764	23.66	16.42	0.2	159	92.3	2.4
Y131H8	546H3 x Y031	7,652	23.38	16.38	0.2	159	94.2	2.4
US H11	546H3 x C36 (80096)	7,439	22.98	16.20	0.2	154	91.7	2.0
Y146H8	546H3 x Y046	7,418	22.48	16.51	0.0	141	92.9	2.0
Y049H8	546H3 x Y949	7,397	23.03	16.07	0.0	159	92.7	2.6
Y152H8	546H3 x Y052	7,243	22.54	16.09	0.2	153	92.8	2.3
Y052H8	546H3 x Y952	7,123	22.52	15.82	0.0	141	93.2	2.9
Y149H8	546H3 x Y049	7,046	22.14	15.95	0.0	152	93.1	2.2
Y141H8	546H3 x Y041	6,935	21.73	15.96	0.0	159	93.0	2.3
U031H8	546H3 x F79-31 (80212)	6,718	21.34	15.77	0.0	154	92.3	2.5
Mean		7,756	23.96	16.19	0.1	153	92.9	2.3
LSD (.05)		501	1.39	0.58	NS	NS	1.2	NS
C. V. (%)		6.5	5.9	3.6	478.5	10.3	1.2	26.1
F value		21.4**	20.5**	1.8*	0.7 NS	1.1 NS	3.6**	1.6 NS

1/ 546H3 = C562CMS x C546; 0755-29 = C301; 0755HO = CMS of S^f, mm, A:aa population; F67-563HO = C563CMS; F80-37 = C37.

2/ Yields adjusted to clean weight basis.

Note: 100% natural infection by Lettuce Infectious Yellows occurred.

TEST B282. IMPERIAL VALLEY HYBRID TEST, 1981-82

16 varieties, 8 replications, RCB
2-row plots, 24 ft. long

Planted: September 3, 1981
Harvested: May 20, 1982

Variety	Description[1/]	Acre Yield[2/] Sugar Pounds	Acre Yield[2/] Beets Tons	Sucrose Percent	Bolting Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating
E137HL4	0757aa x F80-37	9,341	28.76	16.27	0.2	160	93.9	1.8
E137HL6	0755-29aa x F80-37	9,088	28.27	16.10	0.0	144	93.0	1.9
1757HL9	0747aa x 0755	8,164	27.17	15.03	0.0	145	93.5	2.8
E137HL38	0741aa x F80-37	8,122	25.18	16.16	0.4	142	92.3	2.0
E137HL30	0546HL7 x F80-37	8,096	25.55	15.86	0.2	144	91.0	1.8
E137HL2	0755aa x F80-37	8,028	26.21	15.35	0.0	158	92.3	2.4
E137HL41	0745aa x F80-37	7,750	24.45	15.84	0.0	131	91.8	2.2
E137HL39	0742aa x F80-37	7,705	24.85	15.53	0.7	151	92.5	2.3
E137HL40	0744aa x F80-37	7,554	23.35	16.19	0.0	135	92.2	2.3
E137H8	F78-546H3 x F80-37	7,450	23.18	16.08	0.0	146	91.8	2.4
E137HL37	0740aa x F80-37	7,443	23.32	15.95	0.0	140	92.6	2.2
E137HL43	9790aa x F80-37	7,406	22.92	16.15	0.3	146	92.7	1.8
Y146H8	F78-546H3 x Y046	7,374	22.92	16.14	0.0	160	92.8	2.4
Y131HL7,8	0796-1,2aa x Y031	7,177	22.36	16.08	0.0	134	93.6	2.1
US H11	546H3 x C36 (80096)	7,161	23.30	15.39	0.0	149	90.8	2.3
U031H8	546H3 x F79-31 (80212)	6,591	21.27	15.52	0.0	154	92.9	2.4
Mean		7,778	24.57	15.85	0.1	146	92.5	2.2
LSD (.05)		448	1.26	0.48	0.4	16.6	1.3	NS
C. V. (%)		5.8	5.2	3.0	394.5	11.5	1.4	31.3
F value		19.1**	23.1**	4.8**	1.8*	2.2*	3.2**	1.4 NS

1/ 0740, 0741, 0742, 0744, 0745, 0755, 0757, 9790, and 0796 = S^f, mm, A:aa populations; 0755-29 = C301; 0747 = S^f, M, A:aa population; F80-37 = C37.
2/ Yield adjusted to clean weight basis.

Note: 100% natural infection by Lettuce Infectious Yellows occurred.

TEST B382. IMPERIAL VALLEY 755CMS X POLLINATOR HYBRID TEST, 1981-82

8 varieties, 8 replications, RCB
1-row plots, 24 ft. long

Planted: September 3, 1981
Harvested: May 19, 1982

Variety	Description[1]	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating
Y146HL1	0755H0 x Y046	7,361	23.67	15.53	0.0	140	94.2	2.3
E137HL1	0755H0 x F80-37	6,961	23.05	15.10	0.0	131	94.0	2.6
Y149HL1	0755H0 x Y049	6,819	22.48	15.14	0.0	145	95.3	2.1
Y131HL1	0755H0 x Y031	6,702	21.29	15.71	0.0	139	95.8	2.0
Y152HL1	0755H0 x Y052	6,696	22.25	15.04	0.0	133	93.9	2.3
E137H8	F78-546H3 x F80-37	6,503	21.48	15.16	0.0	128	93.8	2.4
Y146H8	F78-546H3 x Y046	6,200	19.75	15.68	0.0	127	93.8	2.0
Y141HL1	0755H0 x Y041	6,088	20.07	15.16	0.4	141	93.8	2.4
Mean		6,666	21.76	15.32	0.05	136	94.3	2.3
LSD (.05)		736	2.10	NS	NS	NS	1.4	NS
C. V. (%)		11.0	9.6	3.8	800.0	19.3	1.4	33.9
F value		2.5*	3.5**	1.9 NS	1.0 NS	0.5 NS	2.7*	0.6 NS

1/ 0755H0 = CMS of S^f, mm, A:aa population 755; 546H3 = C562CMS x C546.

Note: 100% natural infection by Lettuce Infectious Yellows occurred.

TEST B482. IMPERIAL VALLEY EVALUATION OF C2 SYN 1 POPULATIONS OF 790, 1981-82

8 varieties, 8 replications, RCB
2-row plots, 24 ft. long

Planted: September 3, 1981
Harvested: May 22, 1982

Variety[1/]	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Percent	Beets/100' Number	Clean Beets Percent	Nitrate Nitrogen Rating
9790	8790aa x A	6,435	19.92	16.17	0.0	169	94.4	2.3
1790E	9790D-S_1(LSY)aa x A	5,868	18.61	15.79	0.0	159	93.2	2.1
7790D	5790-SY(S_1)aa x A	5,856	18.81	15.57	0.3	150	93.9	2.4
1790C	9790D-S_1(unsel.)aa x A	5,823	18.46	15.78	0.0	159	93.6	1.9
1790D	9790D-S_1(SY)aa x A	5,711	17.88	15.99	0.1	172	91.8	2.0
7790C	5790-CO(S_1)aa x A	5,623	17.88	15.74	0.4	164	93.8	2.0
9790D	T-O-8790D-S_1aa x A	5,552	17.40	15.97	0.2	163	93.6	2.1
7790H	5790-LSY(S_1)aa x A	4,769	14.80	16.13	0.0	145	93.6	1.9
Mean		5,705	17.97	15.89	0.14	160	93.5	2.1
LSD (.05)		464	1.40	NS	NS	14.0	1.3	NS
C. V. (%)		8.1	7.7	3.1	367.0	8.7	1.4	24.1
F value		8.0**	9.2**	1.4 NS	0.9 NS	3.4**	2.9*	0.9 NS

1/ Population 790 (mm, S^f, A:aa) S_1 progenies were evaluated and recombined based upon sugar yield performance: 7790C = CO increased from randomly selected S_1 progenies; 7790D = C1 based upon sugar yield; 7790H = C1 based upon low sugar yield; 1790C = increase of 7790D; 1790D = C2 based upon sugar yield; 9790 = increase of C2 of mass selection.

Note: 100% natural infection to Lettuce Infectious Yellows occurred.

TEST B582. IMPERIAL VALLEY TEST OF HYBRIDS WITH P.M. RESISTANT POLLINATORS, 1981-82

8 varieties, 8 replications, RCB
1-row plots, 24 ft. long

Planted: September 3, 1981
Harvested: May 19, 1982

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Percent	Beets/100' Number	Clean Beets Percent	Nitrate Nitrogen Rating
E137HL3	0755H0 x F80-37	7,845	24.84	15.80	0.7	139	94.7	1.9
Hyb. #3	0755H0 x PM-22	7,649	25.11	15.23	0.0	134	94.6	2.0
Hyb. #6	0755H0 x PM-90	7,648	24.45	15.63	0.0	139	94.6	2.1
Y146H8	F78-546H3 x Y046	7,129	22.00	16.19	0.0	144	94.8	1.9
Y146HL1	0755H0 x Y046	6,820	22.05	15.44	0.0	150	93.3	1.9
0719HL7	8755H0 x 719	6,670	21.93	15.23	0.0	146	93.5	1.9
Y141HL1	0755H0 x Y041	6,401	21.02	15.28	0.7	154	93.6	1.5
US H11	546H3 x C36 (80096)	6,173	20.56	15.01	0.0	137	93.3	2.1
Mean		7,042	22.74	15.48	0.2	143	94.0	1.9
LSD (.05)		920	2.77	NS	NS	NS	NS	NS
C. V. (%)		13.0	12.1	4.8	379.2	12.3	1.6	32.5
F value		3.7**	3.4**	2.1 NS	1.9 NS	1.2 NS	1.6 NS	0.8 NS

Note: 100% natural infection of Lettuce Infectious Yellows occurred.

TEST B682. IMPERIAL VALLEY SEMI-COMMERCIAL HYBRID TEST, 1981-82

8 varieties, 8 replications, RCB
1-row plots, 24 ft. long

Planted: September 3, 1981
Harvested: May 19, 1982

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating
E137HL25	0755H72 x F80-37	8,180	26.21	15.57	0.0	124	93.1	2.4
H79251	Spreckels Hybrid	8,156	24.42	16.71	0.0	157	94.4	1.9
81-7335-05	Holly Hybrid	8,071	25.10	16.11	0.3	135	96.0	2.3
1459-02	Holly Hybrid	7,830	24.06	16.27	0.0	133	96.2	1.4
Y146H8	F78-546H3 x Y046	7,689	23.75	16.21	0.0	134	93.9	2.0
8480-02	Holly Hybrid	7,322	23.29	15.69	0.0	146	95.3	2.5
US H11	546H3 x C36 (80096)	7,294	23.77	15.36	0.0	131	91.5	2.5
H79290	Spreckels Hybrid	7,046	22.13	15.95	0.0	150	93.8	2.0
Mean		7,699	24.09	15.98	0.04	139	94.3	2.1
LSD (.05)		685	2.01	0.62	NS	NS	1.4	NS
C. V. (%)		8.9	8.3	3.9	800.0	20.1	1.4	41.6
F value		3.3**	2.9*	4.0**	1.0 NS	1.3 NS	11.0**	1.5 NS

Note: 100% infection by Lettuce Infectious Yellows occurred.

TEST B1382-4. IMPERIAL VALLEY EVALUATION OF E137HL46 TEST CROSSES, 1981-82

16 varieties, 2 replications, RCB
1-row plots, 24 ft. long

Planted: September 3, 1981
Harvested: May 24, 1982

Variety	Description[1/]	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating
E137HL46-11	1755-11aa x F80-37 (7753)	8,834	27.36	16.15	0.0	152	91.8	1.8
E137HL46-17	1755-17aa x F80-37 (7716)	8,752	27.72	15.80	0.0	161	94.0	2.8
E137HL46-5	1755-5aa x F80-37 (7757)	8,519	27.24	15.63	0.0	163	92.9	2.8
E137HL46-2	1755-2aa x F80-37 (7704)	8,519	28.44	14.97	0.0	165	92.7	3.8
E137HL46-1	1755-1aa x F80-37 (7704)	8,153	25.88	15.76	0.0	142	92.1	3.0
E137HL2	0755aa x F80-37 (check)	8,100	27.31	14.86	0.0	181	90.4	3.3
E137HL46-7	1755-7aa x F80-37 (9760)	8,097	26.17	15.48	0.0	181	92.0	2.0
E137HL46-16	1755-16aa x F80-37 (7716)	8,033	24.69	16.28	0.0	156	93.8	1.5
E137HL46-10	1755-10aa x F80-37 (7754)	8,020	26.20	15.34	0.0	152	92.3	2.8
E137HL46-6	1755-6aa x F80-37 (7757)	7,959	25.56	15.55	1.5	150	93.4	2.0
E137HL46-14	1755-14aa x F80-37 (9703)	7,380	24.12	15.34	0.0	140	92.8	3.0
E137HL46-8	1755-8aa x F80-37 (9760)	7,242	25.10	14.44	0.0	144	90.0	3.8
E137HL46-9	1755-9aa x F80-37 (7754)	6,957	23.79	14.60	0.0	161	88.8	3.8
E137HL46-3	1755-3aa x F80-37 (7734)	6,933	23.90	14.51	0.0	163	86.9	3.0
E137HL46-13	1755-13aa x F80-37 (9703)	6,646	22.20	14.93	0.0	161	92.1	3.0
E137HL46-4	1755-4aa x F80-37 (7734)	6,499	22.40	14.48	0.0	152	89.2	2.3
Mean		7,790	25.50	15.26	0.1	158	91.6	2.8
LSD (.05)		1304	3.15	NS	NS	21.5	NS	NS
C. V. (%)		7.9	5.8	5.1	565.7	6.4	2.9	32.2
F value		3.0*	3.2*	1.2 NS	1.0 NS	2.8*	1.1 NS	1.3 NS

1/ 1755-1 thru -17 are F_2 lines that were combined to produce the original 755 populations. Eight MM, S^f inbreds were crossed to two mm, S^f, aa females. The original MM inbred is listed to the right of the test crosses. 0755 is an advanced population derived from the original 755 population.

Note: 100% infection to Lettuce Infectious Yellows occurred.

TEST B882. IMPERIAL VALLEY FODDER BEET TEST, 1981-82

6 varieties, 5 replications, RCB
2-row plots, 24 ft. long, 32 in. rows

Planted: September 3, 1981
Harvested: May 24, 1982

Variety	Description	Acre Yield1/ Sugar Pounds	Acre Yield1/ Beets Tons	Sucrose Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating2/
Y146HL1	0755H0 x Y046	8,284	25.29	16.39	156	90.9	1.2
US H11	546H3 x C36 (80096)	7,195	22.17	16.24	160	91.5	1.6
Mono Fix	FB 56 (Logan)	6,890	25.27	13.72	154	93.7	2.4
Oscar	FB 19 (Logan)	6,652	31.97	10.63	136	95.0	4.0
Barb. 79-1	FB 52 (Logan)	5,582	23.57	11.99	146	92.5	3.2
Hugin	FB 62 (Logan)	5,307	21.25	12.51	163	93.1	3.1
Mean		6,652	24.92	13.58	152	92.8	2.6
LSD (.05)		1,033	2.82	1.84	NS	1.8	0.8
C. V. (%)		11.8	8.6	10.3	9.9	1.5	24.3
F value		9.7**	16.0**	14.1**	2.2 NS	5.8**	14.2**

1/ Yields adjusted to clean weight basis.

2/ Brei NO_3-N by Orion probe. Ratings of 1, 2, ..., 9 correspond to NO_3-N values of 0 to >250 ppm.

Note: 100% infection by Lettuce Infectious Yellows occurred.

U.C. DAVIS VARIETY TRIAL, DAVIS, CALIFORNIA, 1982
By Dr. F. J. Hills

8 varieties x 6 replications, RCB
2-row plots, 50 ft. long

Planted: May 3, 1982
Harvested: October 20, 1982

Variety	% Mature leaf area diseased						Roots		
								Sugar	
	July 27	Aug 9	Aug 24	Sep 7	Sep 23	Mean*	Yield	Conc.	Yield
							Ton/acre	%	100 lb/acre
US H11	85	91	90	83	22	84.9	18.8	14.3	54.1
Y146H8	67	88	89	75	21	76.4	17.7	15.0	53.0
Y131H8	68	87	85	78	23	76.1	19.5	14.4	56.0
Y049H33	64	79	74	66	21	68.7	20.3	14.6	58.9
E137HL29	85	89	87	81	32	83.9	20.4	14.4	58.5
Y146HL1	73	87	81	81	21	77.4	19.2	14.9	57.2
Monoricca	70	79	74	78	25	72.5	21.0	16.2	67.9
9421	70	80	72	84	34	73.4	20.4	15.3	62.1
LSD, 5%							2.0	0.4	6.5
CV, %							8.7	2.2	9.5

*Biweekly ratings weighted by weeks to October 1: eg 84.9 = 9(85)+7(91)+5(90)+3(83)+1(22)/25.

Eight varieties were compared at Davis in a trial in which powdery mildew was not controlled. The first six varieties listed are hybrids developed at Salinas that are resistant to CT, VY, ERR, and bolting. Monoricca (Hilleshog) and 9421 (Betaseed) are proprietary varieties. Powdery mildew was severe but other diseases were very light. US H11 was the most susceptible variety to mildew. These data suggest that genetic variability exists to significantly improve the productivity of varieties with multiple disease resistance.

1982 TRIAL, WOODLAND, CALIFORNIA
AMSTAR CORPORATION, SPRECKELS SUGAR DIVISION
Supervised by E. M. Holst

12 varieties x 8 replications

Planted: April 29, 1982
Harvested: October 27, 1982

Entry	Acre Yield Sugar Tons	Acre Yield Beets Tons	Sugar %	Brei NO_3-N PPM	Beets/ 100' Number	Emergence Rate
0755H0 x F80-37	1.759	14.1	12.5	58	110	3.4
MS72467 x C42	1.565	12.7	12.7	64	141	1.3
MS72467 x C36	1.494	12.3	12.3	67	126	2.1
C546H3 x Y952	1.489	12.5	12.0	66	160	2.1
C546H3 x Y046	1.462	11.3	13.0	52	136	1.8
C301CMS x F80-37	1.421	11.7	12.5	46	115	2.9
MS72467 x C37	1.290	10.7	12.2	55	151	1.5
C546H3 x C719	1.130	9.0	12.8	51	133	1.4
Mean	1.480	11.9	12.6	61	137	2.1
LSD (.05)	0.364	NS	NS	19	17	0.7
SE in % of mean	8.71	8.7	2.4	11	7	11.3

Notes: Moderate-severe nematodes (stubby root, root knot, and sugarbeet cyst). An early nitrogen deficiency corrected by fertilizer.

1982 TRIAL, MENDOTA, CALIFORNIA
AMSTAR CORPORATION, SPRECKELS SUGAR DIVISION
Supervised by L. M. Burtch

12 varieties x 8 replications

Planted: February 9, 1982
Harvested: September 29, 1982

Entry	Acre Yield Sugar Tons	Acre Yield Beets Tons	Sugar %	Brei NO_3-N PPM	Beets/ 100' Number	Emergence Rate
C301CMS x F80-37	3.621	31.2	11.5	15	146	1.5
C546H3 x Y046	3.580	29.7	12.1	14	151	1.4
C546H3 x C719	3.335	28.0	11.9	14	154	2.1
MS72467 x C42	3.312	28.8	11.5	19	154	1.3
C546H3 x Y952	3.288	28.5	11.5	20	145	1.1
MS72467 x C37	3.129	25.3	12.3	14	154	1.0
MS72467 x C36	3.070	26.9	11.4	15	145	2.1
C546H3 x C817	2.755	24.3	11.2	13	157	1.6
Mean	3.206	27.5	11.7	16	151	1.4
LSD (.05)	0.425	3.1	0.7	NS	NS	0.6
SE in % of mean	4.73	4.1	2.3	12	3	15.1

Notes: Low sugars with low nitrogen probably due to rainfall a week prior to harvest.

SPRING PLANT-FALL HARVEST SCREENING TEST 1
WOODLAND, CALIFORNIA
BY BETASEED

25 varieties x 6 replications
Balanced lattice

Planted: June 10, 1982
Harvested: December 13, 1982

Variety	Description	Acre Yield Sugar Lbs/A	Acre Yield Beets Tons	Sucrose %	Rec. Sugar Lbs/A	Qual. Index	Impurity K MEQ	Impurity Na MEQ	Impurity A-N MEQ
US H11	546H3 x C36 (80096)	6,760	32.4	10.4	4,316	63.6	4.87	4.33	3.5
SS-E1	Spreckels	6,910	31.3	11.0	4,644	67.0	4.86	3.95	3.3
US H10	546H3 x C17	6,488	32.2	10.0	3,939	60.4	4.85	4.85	3.5
HH22	Holly	6,297	30.3	10.4	3,995	63.5	4.98	4.33	3.2
Y146H8	546H3 x Y046	7,796	33.9	11.5	5,464	69.9	4.74	3.58	3.3
Y149H8	546H3 x Y049	7,661	35.2	10.8	4,968	64.4	4.79	4.61	3.4
Y023H8	546H3 x Y123	7,903	35.4	11.3	5,189	65.8	5.00	4.36	3.3
Y131H8	546H3 x Y031	7,732	34.7	11.1	5,044	65.1	4.82	4.70	3.3
E137HL5	C301CMS x F80-37	7,544	33.1	11.4	5,159	68.4	5.18	3.48	3.4
E137HL29	0546H72 x F80-37	6,967	31.5	11.1	4,651	66.7	5.44	3.52	3.3
E137HL1	0755H0 x F80-37	7,396	33.7	11.0	4,977	66.9	4.94	3.79	3.4
Mean		7,440	33.1	11.2	4,968	66.6	4.7	4.4	3.3
LSD (.05)		926	3.9	0.7	747	3.2	0.2	0.5	0.1
C. V.		10.9	10.2	5.2	13.2	4.0	4.3	9.7	3.9
F level		**	**	**	**	**	**	**	**

AMSTAR CORP., SPRECKELS SUGAR DIVISION

1982 BOLTING & PM DATA FOR SALINAS USDA ENTRIES FROM THE SPRECKELS BOLTING NURSERY

(Average of 3 Replications)
Planted Dec. 7, 1981

Entry	Rate of Emerg.	% Bolting 7-19	% Bolting 9-16	PM 7-19	Color 7-19	Vigor 7-19	Total No. Plants in All Reps
SS-E1	3.0	0	1	5.3	2.3	2.7	140
546H3 x Y046	3.0	1	2	5.3	2.0	3.0	153
C301cms x C37	2.3	1	2	5.3	2.3	1.3	151
546H3 x 719	3.0	3	12	6.3	1.7	2.7	161
" x Y952	2.7	3	6	6.3	2.3	2.3	155
" x Y052	3.3	2	6	6.3	2.0	2.7	130
" x Y049	3.7	1	3	5.3	2.3	2.7	137
" x C31E2	3.0	1	2	4.3	2.0	3.3	149
" x Y041	3.3	1	6	5.0	2.6	2.0	161
" x F80-37	3.6	0	4	5.3	2.0	2.3	142
(755 x C546) x F80-37	2.7	0	3	4.7	2.3	1.3	152
755 x F80-37	3.0	0	3	4.3	2.0	1.7	145
757 x F80-37	3.7	2	5	3.3	2.0	1.7	133
C758	4.0	0	0	3.3	4.3	7.7	116
C758H0 x 546E	4.0	2	6	4.3	3.0	4.0	121
C566	3.7	0	0	3.0	4.7	7.0	145
C566 cms	3.7	2	2	4.0	4.7	5.7	139
C563H0 x C566	3.7	0	1	4.3	4.3	6.3	92
C301	2.7	0	0	2.7	4.3*	7.0	148
C301 cms	3.3	0	1	3.0	4.0*	5.7	142
C301 cms x C546	3.0	4	9	4.3	4.0	4.0	137
C718 cms x C301	3.7	1	7	4.3	3.7	5.0	135
C413, L0268	5.3	2	6	6.7	1.7	3.7	84
C01	4.0	12	19	4.0	1.7	3.0	129
C36, L80218	3.0	3	5	6.3	2.0	4.3	141
C46	3.0	2	2	3.0	1.3	3.0	131
C42	3.0	5	13	2.7	2.0	3.7	132
C37	2.7	1	1	5.3	1.3	3.7	139
RANGES IN ENTIRE NURSERY							
Hybrids	1.0-4.7	0-86	0-86	2.7-7.7	1.0-3.7	1.0-3.3	59-192
Monogerms	1.7-6.0	0-92	0-92	1.3-8.3	2.0-5.0	2.2-9.0	40-172
Multigerms	1.3-6.0	0-99	0-100	2.3-8.3	1.3-4.7	1.0-8.0	83-163

Emergence: Scores on Dec. 22 based on 1 = Fast to 6 = Very slow.
Powdery Mildew: Based on 0 = None to 10 = 100% of leaves infected.
Color of Foliage: Based on 1 = Dark green to 5 = Very light green.
Vigor of Canopy: Based on 1 = Very large tops to 9 = Very small tops.

*Severe *Alternaria* infection.

Submitted by: J. D. Schulke

TEST 1782. ERWINIA AND POWDERY MILDEW EVALUATION TEST
SALINAS, CALIFORNIA, 1982

48 varieties x 2 replications
1-row plots, 30 ft. long

Planted: February 24, 1982
Inoculated (E): July 28, 1982
Harvested: November 3, 1982

			Erw. Reaction		Powdery Mildew Scores3/		
Variety	Description	No. Roots	DI1/	% Healthy2/	7/22	8/14	9/6
E0206	Amalgamated	88	0.10	98.8	3.0	6.0	4.5
E0207	Amalgamated	93	0.10	100.0	4.0	7.0	5.5
E0209	Amalgamated	90	0.10	100.0	4.0	7.0	7.0
US H11	80096	93	0.20	100.0	4.0	7.0	7.0
E0134	Amalgamated	98	3.76	92.8	2.5	5.5	6.0
E1142	TASCO	88	1.33	95.7	0.5	0.5	0.5
E1148	TASCO	90	0.01	99.0	1.5	1.5	1.0
E1146	TASCO	87	0.46	96.5	1.0	1.5	1.0
E1152	TASCO	93	0.08	99.0	1.0	1.0	1.0
Y146H8	F78-546H3 x Y046	87	1.20	95.4	2.5	4.5	6.0
0G5545	Betaseed	86	0.00	100.0	2.5	3.5	4.5
1C0104	Betaseed	81	1.22	97.6	1.5	3.0	4.0
1G5651	Betaseed	71	1.89	97.2	3.0	5.0	5.5
1G5652	Betaseed	75	4.47	95.9	3.0	5.5	5.0
1G5655	Betaseed	91	1.39	94.5	1.5	2.5	3.5
1G5656	Betaseed	83	0.85	96.4	3.0	6.0	6.0
1G5657	Betaseed	87	0.10	97.7	1.5	3.0	3.0
1G5677	Betaseed	85	2.07	96.4	2.0	4.0	4.0

1/ DI = Disease Index = Mean % rot/root. Plants scored on a scale of 0, 1, 7, 25, 50, 75, 93, and 100% rot per root.

2/ Roots with scores of 0 and 1% rot were considered healthy.

3/ Powdery mildew ratings made on a scale of 0 to 9.

Powdery mildew appeared in late June but did not develop until mid-July. A peak level of infection occurred near the 8/14/82 date of rating. The ratings made on 9/6/82 reflected chronic levels of disease in which many older leaves with severe mildew had already died on susceptible lines but not on the most resistant lines. The reliability of these ratings should be good.

The data for erwinia root rot are not so reliable. The test was wound-inoculated in the mid-afternoon when the leaves were slightly wilted and apparently the large roots were insufficiently wounded for high levels of infection to become established. However, even at low levels of infection, we have found that ratings usually reflect the relative host-plant reaction of the varieties being tested.

TEST 1782. ERWINIA AND POWDERY MILDEW EVALUATION TEST (CONTINUED)
SALINAS, CALIFORNIA, 1982

48 varieties x 2 replications
1-row plots, 30 ft. long

Planted: February 24, 1982
Inoculated (E): July 28, 1982
Harvested: November 3, 1982

Variety	Description	No. Roots	Erw. Reaction DI	Erw. Reaction % Healthy	Powdery Mildew Scores 7/22	8/14	9/6
81-7334-05	Holly	62	1.76	95.3	3.0	4.5	5.0
81-7334-03	Holly	83	2.70	95.2	2.0	3.5	3.5
81-7335-05	Holly	80	4.81	87.4	2.0	4.0	4.5
81-7335-07	Holly	83	5.57	92.9	3.0	4.5	5.5
US H11	(80096)	84	1.19	97.8	3.0	6.0	6.5
8480-02	Holly	80	1.27	97.5	1.5	3.0	4.0
1459-02	Holly	88	2.82	95.4	1.5	3.0	4.5
1459-04	Holly	81	0.00	100.0	3.5	4.5	5.0
S-311H	Spreckels	79	0.11	98.7	3.0	3.5	5.0
S-101H16	Spreckels	91	2.31	93.5	4.0	5.5	6.0
SS-Z1	Spreckels	89	1.09	98.9	3.5	6.0	5.0
US H11	(80096)	89	0.18	97.6	4.0	6.5	5.5
9421	Betaseed	84	6.20	90.4	2.0	3.5	4.0
BJ19	Bush-Johnsons	77	5.56	91.3	2.0	4.0	4.0
80MSC9	Great Western	80	4.98	91.6	4.5	7.0	7.0
MonoHy D2	Great Western	85	1.92	93.0	4.0	5.5	5.5
GWH149	Great Western	84	4.88	91.6	4.0	7.0	6.5
Mono 309	Hilleshog	86	0.17	97.7	2.0	5.0	6.0
U137H8	(81060)	86	1.39	96.5	3.5	6.0	6.5
Y131H8	F78-546H3 x Y031	86	3.37	93.1	3.5	3.5	5.5
Y149H8	F78-546H3 x Y049	90	0.96	97.8	3.0	5.0	6.0
NS-Hy-11	Nova Sad	92	4.83	90.3	2.5	3.5	5.0
Monoricca	Hilleshog	91	1.29	97.9	1.5	2.0	3.5
HH27	Holly	86	0.08	98.9	1.0	5.0	1.5
Y141H8	F78-546H3 x Y041	81	0.12	98.8	2.0	3.0	4.0
Y141HL1	0755H0 x Y041	89	0.68	96.7	2.5	3.0	3.0
E137HL2	0755aa x F80-37	85	0.40	97.8	4.0	4.5	4.0
US H11	80096	86	0.40	97.6	4.0	6.5	6.5
Y146H8	F78-546H3 x Y046	90	0.01	100.0	3.0	4.5	5.0
Y146HL1	0755H0 x Y046	90	0.18	97.7	2.0	3.0	3.5

TEST 1781-NONINOCULATED. YELLOWS & PERFORMANCE EVALUATION OF ADVANCED HYBRIDS
SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
8 varieties and 2 virus treatments
1-row plots, 37 ft. long

Planted: March 12, 1981
Noninoculated1/
Harvested: October 19, 1981

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot
		Pounds	Tons	Percent	Number	Percent
U031H8	546H3 x C31E2 (80212)	15,107	43.44	17.38	131	0.5
0722H8	F78-546H3 x 8722C1	14,458	42.78	16.90	134	0.2
Y052H8	F78-546H3 x Y952	14,224	42.04	16.92	130	0.0
E037H8	F78-546H3 x E937 (C37)	13,969	42.13	16.57	132	0.3
0719H8	F78-546H3 x SF-C17	13,674	40.58	16.85	134	0.7
E037H27	C758H0 x E937 (C37)	13,210	39.70	16.65	136	0.3
US H11	F78-546H3 x F78-36 (80096)	13,190	40.38	16.34	139	0.0
Y049H8 2/	F78-546H3 x Y949	13,041	38.81	16.81	127	0.8
Mean		13,859	41.23	16.80	133	0.3
LSD (.05)		891	2.27	0.43	NS	NS
C. V. (%)		6.4	5.5	2.5	5.7	273.4
F value		5.3**	4.1**	4.1**	1.9 NS	0.8 NS

1/ The BYV-BWYV performance and % loss data are summarized on the following page.

2/ In terms of foliar appearance and disease reaction, this entry is probably not Y049H8.

TEST 1781-BYV-BWYV INOCULATED. YELLOWS & PERFORMANCE EVALUATION OF ADVANCED HYBRIDS
SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
8 varieties and 2 virus treatments
1-row plots, 37 ft. long

Planted: March 12, 1981
BYV-BWYV Inoculated: May 20, 1981
Harvested: October 19, 1981

Variety	Description	Sugar Yield Inoc.	Sugar Yield Loss	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Beets/ 100'	Root Rot
		Lbs/A	%	T/A	%	%	%	Number	%
E037H8	F78-546H3 x E937 (C37)	9,449	32.4	30.39	28.2	15.59	5.8	133	0.0
U031H8	546H3 x C31E2 (80212)	9,382	37.7	30.02	30.9	15.66	9.9	124	0.0
Y052H8	F78-546H3 x Y952	9,341	33.9	29.82	29.1	15.71	7.1	128	0.0
0719H8	F78-546H3 x SF-C17	9,252	31.7	29.55	26.9	15.68	6.8	120	0.3
0722H8	F78-546H3 x 8722C1	8,964	37.7	28.65	32.7	15.64	7.4	136	0.0
E037H27	C758H0 x E937	8,662	34.6	27.96	29.7	15.52	6.7	133	0.0
US H11	F78-546H3 x F78-36 (80096)	8,158	38.0	27.40	32.0	14.91	8.7	138	0.0
Y049H8	F78-546H3 x Y949	6,807	47.3	23.02	40.3	14.78	12.0	129	0.0
Mean		8,752	36.7	28.35	31.2	15.44	8.1	130	0.03
LSD (.05)		692	5.8	1.77	4.7	0.48	3.5	9.4	NS
C. V. (%)		7.8	15.7	6.2	14.9	3.1	43.3	7.1	800.0
F value for varieties		13.8**	5.9**	14.9**	6.3**	4.9**	2.7*	3.3**	1.0 NS
F value for virus		358.1**		468.0**		74.6**		0.3 NS	2.1 NS
F value for variety x virus		3.0**		2.8*		2.4*		1.5 NS	0.6 NS

TEST 1881-NONINOCULATED. YELLOWS & PERFORMANCE EVALUATION OF ADVANCED USDA & COMPANY HYBRIDS
SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
8 varieties and 2 virus treatments
1-row plots, 37 ft. long

Planted: March 12, 1981
Noninoculated1/
Harvested: October 20, 1981

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot
		Pounds	Tons	Percent	Number	Percent
7335-02	Holly (Rec'd. 2/10/81)	15,427	44.60	17.32	125	0.5
H79287	Spreckels (Rec'd. 2/4/81)	15,420	44.80	17.23	143	0.0
Y031HL7	8755H0 x F79-31	14,945	44.19	16.92	139	0.0
9421	Betaseed (Rec'd. 2/6/81)	14,468	42.54	17.03	142	1.9
Mono 309	Hilleshog (Rec'd. 2/21/80)	14,452	44.14	16.36	147	0.2
E037H8	F78-546H3 x E937 (C37)	14,300	43.72	16.36	135	0.0
80MSC9	Great Western (Rec'd. 2/11/81)	13,839	41.15	16.82	142	1.4
US H11	F78-546H3 x F77-36 (80096)	13,812	42.98	16.07	143	0.0
Mean		14,583	43.51	16.76	140	0.5
LSD (.05)		826	NS	0.45	7.5	1.1
C. V. (%)		5.6	5.4	2.70	5.3	210.1
F value		4.8**	2.2 NS	8.2**	6.8**	3.9**

1/ The BYV-BWYV inoculated performance data are summarized on the following page.

TEST 1881-BYV-BWYV INOCULATED. YELLOWS & PERFORMANCE EVALUATION OF ADVANCED USDA & COMPANY HYBRIDS
SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
8 varieties and 2 virus treatments
1-row plots, 37 ft. long

Planted: March 12, 1981
BYV-BWYV Inoculated: May 20, 1981
Harvested: October 20, 1981

Variety	Description	Sugar Yield Inoc.	Sugar Yield Loss	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Beets/ 100'	Root Rot	Yellows Score 2/
		Lbs/A	%	T/A	%	%	%	Number	%	
Y031HL7	8755H0 x F79-31	10,411	29.9	33.11	24.7	15.73	7.0	135	0.0	5.5
7335-02	Holly (Rec'd. 2/10/81)	9,673	36.9	30.29	31.7	15.97	7.8	121	0.3	6.3
E037H8	F78-546H3 x E937 (C37)	9,554	32.6	31.40	27.7	15.24	6.8	130	0.0	6.0
9421	Betaseed (Rec'd. 2/6/81)	8,984	37.7	28.88	32.1	15.57	8.5	140	0.5	7.1
H79287	Spreckels (Rec'd. 2/4/81)	8,877	41.8	28.36	36.2	15.69	8.9	139	0.0	7.5
US H11	F78-546H3 x F77-36 (80096)	8,587	37.8	29.09	32.3	14.76	8.1	139	0.0	6.3
Mono 309	Hilleshog (Rec'd. 2/21/80)	8,385	41.3	29.16	33.5	14.39	12.0	139	0.0	7.6
80MSC9	Great Western (Rec'd. 2/11/81)	8,066	41.5	27.63	32.9	14.63	12.9	148	0.0	7.1
Mean		9,067	37.4	29.74	31.4	15.25	9.0	137	0.1	6.7
LSD (.05)		703	5.9	2.02	5.8	0.47	3.7	6.5	NS	0.8
C. V. (%)		7.7	15.6	6.7	18.4	3.0	40.4	4.7	429.4	11.3
F value for varieties		9.8**	4.4**	6.3**	3.1*	12.8**	3.1*	12.8**	1.7 NS	7.9**
F value for virus		308.7**		415.8**		70.0**		0.9 NS	8.0*	
F value for varieties x virus		2.5*		2.0 NS		2.4*		1.5 NS	2.3*	

2/ Severity of yellows symptoms rated from 0 (no symptoms) to 9.

TEST 1981-NONINOCULATED. YELLOWS & PERFORMANCE EVALUATION OF S^f, MONOGERM POPULATION HYBRIDS, SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
8 varieties and 2 virus treatments
1-row plots, 37 ft. long

Planted: March 17, 1981
Noninoculated1/
Harvested: October 26, 1981

Variety	Description2/	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/ 100' Number	Root Rot Percent
E037HL15	9755aa x E837	14,261	42.89	16.60	114	1.1
E037HL3	9718HL11 x E937	14,048	42.99	16.36	117	0.9
E037H8	F78-546H3 x E937	13,669	41.28	16.57	119	0.0
E037HL12	9744aa x E837	13,491	39.07	17.28	111	1.0
E037HL13	9745aa x E837	13,470	40.58	16.65	89	0.5
E037HL9	9740aa x E837	13,047	38.44	16.97	111	1.3
E037HL11	9742aa x E837	12,579	38.63	16.28	95	1.0
E037HL10	9741aa x E837	12,413	36.53	16.97	100	0.8
Mean		13,372	40.05	16.71	107	0.8
LSD (.05)		1,008	3.03	0.43	11.23	NS
C. V. (%)		7.5	7.5	2.6	10.40	208.4
F value		3.5**	4.6**	4.9**	7.8**	0.4 NS

1/ The BYV-BWYV inoculated performance and % loss data are summarized on the following page.

2/ 9740-9755 = S^f, mm populations that segregate for genetic male sterility (aa). 9718H11 = 755CMS x C718.

TEST 1981-BYV-BWYV INOCULATED. YELLOWS & PERFORMANCE EVALUATION OF S^f, MONOGERM POPULATION HYBRIDS
SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
8 varieties and 2 virus treatments
1-row plots, 37 ft. long

Planted: March 17, 1981
BYV-BWYV Inoculated: May 20, 1981
Harvested: October 26, 1981

Variety	Description	Sugar Yield Inoc.	Sugar Yield Loss	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Beets/ 100'	Root Rot
		Lbs/A	%	T/A	%	%	%	Number	%
E037HL15	9755aa x E837	10,101	27.5	31.30	25.8	16.14	2.7	109	0.0
E037HL3	9718HL11 x E937	9,298	33.6	29.74	30.6	15.63	4.3	123	0.0
E037HL11	9742aa x E837	8,913	28.8	29.43	23.6	15.13	6.9	102	0.5
E037HL13	9745aa x E837	8,909	33.9	28.76	29.0	15.49	6.8	97	0.0
E037HL9	9740aa x E837	8,785	31.7	27.60	27.6	15.93	6.0	112	0.3
E037HL12	9744aa x E837	8,738	34.8	27.28	29.8	16.01	7.3	115	0.0
E037H8	F78-546H3 x E937	8,614	36.3	27.61	32.8	15.64	5.5	133	0.0
E037HL10	9741aa x E837	7,987	34.9	25.05	30.6	15.92	6.1	111	0.0
Mean		8,918	32.7	28.35	28.7	15.74	5.7	113	0.1
LSD (.05)		692	NS	1.88	NS	0.46	NS	12.4	NS
C. V. (%)		7.7	22.9	6.6	25.1	2.9	62.5	10.9	594.2
F value for varieties		6.2**	1.4 NS	8.3**	1.3 NS	4.1**	1.5 NS	6.9**	0.8 NS
F value for virus		185.7**		215.9**		35.5**		4.8 NS	13.3**
F value for variety x virus		0.8 NS		1.1 NS		1.5 NS		1.1 NS	0.4 NS

TEST 2081-NONINOCULATED. GENETIC ADVANCE FOR YELLOWS RESISTANCE
SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
8 varieties and 2 virus treatments
1-row plots, 37 ft. long

Planted: March 12, 1981
Noninoculated1/
Harvested: October 22, 1981

Variety2/	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/ 100' Number	Root Rot Percent	Bolting Percent
964H8	546H3 x 364	13,585	41.07	16.61	144	0.3	0.0
917H8	546H3 x 417	12,865	39.35	16.38	131	0.9	0.0
964H2	4547H1 x 364	12,358	38.75	15.93	126	1.1	0.0
915	Inc. 915	12,230	36.89	16.68	135	0.8	0.0
Y905	Inc. 68-9163	11,673	33.45	17.44	128	0.4	0.0
959	Inc. 959	11,655	35.74	16.31	118	0.3	0.0
968	Inc. 468	11,428	35.97	15.90	125	0.5	0.0
Y009	Inc. US 22/3	10,847	32.39	16.76	115	0.4	3.3
Mean		12,080	36.70	16.50	128	0.6	0.4
LSD (.05)		884	2.24	0.57	10.1	NS	1.3
C. V. (%)		7.2	6.0	3.5	7.8	200.1	302.7
F value		7.9**	14.2**	6.1**	6.6**	0.6 NS	7.0**

1/ BYV-BWYV inoculated performance data are summarized on the following page.

2/ USDA productions of: 964H8 = US H7A, 917H8 = US H10B, 964H2 = US H6, 915 = US 15, 959 = US 56/2, 868 = US 75, Y905 = R & G Pioneer.

TEST 2081-BYV-BWYV INOCULATED. GENETIC ADVANCE FOR YELLOWS RESISTANCE
SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
8 varieties and 2 virus treatments
1-row plots, 37 ft. long

Planted: March 12, 1981
BYV-BWYV Inoculated: May 20, 1981
Harvested: October 22, 1981

Variety	Description	Sugar Yield Inoc.	Sugar Yield Loss	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Beets/ 100'	Root Rot	Bolting	Yellows Score
		Lbs/A	%	T/A	%	%	%	Number	%	%	
917H8	546H3 x 417	8,571	33.2	28.71	27.0	14.95	8.5	134	0.0	0.0	5.8
964H8	546H3 x 364	7,830	41.9	26.91	34.2	14.57	11.8	142	0.0	0.0	7.0
964H2	4547H1 x 364	6,133	50.0	22.19	42.7	13.83	12.9	119	0.0	0.0	7.3
Y905	Inc. 68-9163	5,934	48.8	20.53	38.5	14.46	16.9	127	0.3	0.0	8.0
959	Inc. 959	5,847	49.8	20.93	41.5	13.94	14.3	124	0.3	0.0	7.4
Y009	Inc. US 22/3	5,591	47.8	19.61	38.8	14.24	15.0	120	0.0	2.9	7.4
968	Inc. 468	5,472	51.7	20.61	42.4	13.24	16.5	120	0.5	0.0	7.0
915	Inc. 915	5,274	56.8	20.05	45.5	13.19	20.8	134	0.0	0.3	8.1
Mean		6,331	47.5	22.44	38.8	14.05	14.6	127	0.1	0.4	7.2
LSD (.05)		764	6.8	2.15	6.0	0.66	5.0	9.2	NS	1.0	0.7
C. V. (%)		12.0	14.2	9.5	15.2	4.6	34.1	7.2	392.0	248.8	9.0
F value for varieties		20.1**	8.8**	20.8**	7.8**	7.3**	4.4**	6.7**	1.2 NS	8.6**	10.0**
F value for virus		535.3**		705.7**		65.3**		0.0 NS	4.7 NS	0.0 NS	
F value for variety x virus		3.3**		3.5**		4.3**		0.7 NS	0.9 NS	0.1 NS	

TEST 2181-NONINOCULATED. YELLOWS & PERFORMANCE EVALUATION OF O.P. LINES
SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
16 varieties and 2 virus treatments
1-row plots, 37 ft. long

Planted: March 17, 1981
Noninoculated[1/]
Harvested: November 2-3, 1981

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/100' Number	Root Rot Percent
Y039	NB Y839	14,605	41.62	17.48	120	0.3
Y042 (C42)	YR-ER Y842	13,911	40.73	17.02	113	1.2
F79-31	Inc. C31E2 (79427)	13,685	39.85	17.14	116	0.6
Y046	NB Y846	13,066	39.57	16.51	108	0.6
Y031	NB Y831E	12,979	38.96	16.62	109	0.6
Y052	Inc. Y952	12,792	38.23	16.61	104	0.4
Y049	Inc. Y949	12,758	38.88	16.40	104	0.7
968	Inc. 468 (US 75)	12,141	38.22	15.90	113	1.4
0755	9755aa x A	11,922	36.38	16.36	116	0.0
964	Inc. 364 (C64)	11,788	37.80	15.61	107	0.3
Y041	NB Y841	11,742	35.73	16.32	116	0.0
SP6822-0	Lot 6519	11,229	34.59	16.24	118	1.3
917	Inc. 417 (C17)	11,210	35.05	16.03	114	5.3
F78-36	Inc. F77-36 (78087)	10,982	34.69	15.76	119	0.0
E037	Inc. E937 (C37)	10,677	31.74	16.86	115	0.0
F80-37	Inc. C37	10,507	31.77	16.61	125	0.0
Mean		12,250	37.11	16.47	114	0.8
LSD (.05)		1,768	4.89	0.66	9.2	2.5
C. V. (%)		14.6	13.3	4.1	8.1	318.9
F value		3.7**	2.9**	4.6**	3.3**	2.1*

1/ The BYV-BWYV inoculated performance and % loss data are summarized on the following page.

TEST 2181-BYV-BWYV INOCULATED. YELLOWS & PERFORMANCE EVALUATION OF O.P. LINES
SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
16 varieties and 2 virus treatments
1-row plots, 37 ft. long

Planted: March 17, 1981
BYV-BWYV Inoculated: May 20, 1981
Harvested: November 2-3, 1981

		Sugar Yield		Beet Yield		Sucrose		Beets/	Root	Yellows
Variety	Description	Inoc.	Loss	Inoc.	Loss	Inoc.	Loss	100'	Rot	Score
		Lbs/A	%	T/A	%	%	%	Number	%	6/30
Y049	Inc. Y949	10,249	18.7	31.68	18.1	16.22	1.0	113	1.3	4.8
F79-31	Inc. C31E2 (79427)	9,900	27.7	30.70	23.0	16.05	6.3	115	0.3	5.5
Y042 (C42)	YR-ER Y842	9,622	30.5	30.53	25.0	15.71	7.6	111	0.3	5.8
Y031	NB Y831E	9,541	25.7	30.36	21.6	15.71	5.3	122	0.0	5.4
Y039	NB Y839	8,953	38.1	28.38	31.2	15.69	10.2	120	0.3	6.8
Y052	Inc. Y952	8,724	31.7	28.30	25.9	15.31	7.9	115	0.6	5.6
Y046	NB Y846	8,366	35.5	27.13	31.1	15.42	6.4	106	0.3	6.0
Y041	NB Y841	8,230	29.4	26.07	27.0	15.68	3.7	115	0.3	6.5
F80-37	Inc. C37	8,224	22.1	26.72	16.1	15.43	7.0	130	0.0	4.6
E037	Inc. E937 (C37)	8,119	23.1	25.66	18.4	15.81	6.1	119	0.0	4.5
917	Inc. 417 (C17)	8,090	27.3	26.59	23.5	15.19	5.0	116	1.8	5.1
F78-36	Inc. F77-36 (78087)	7,366	30.8	24.48	28.2	15.08	4.0	123	0.0	4.9
0755	9755aa x A	7,008	41.1	24.53	32.6	14.26	12.8	117	0.0	8.0
968	Inc. 468 (US 75)	6,081	49.8	22.43	41.2	13.44	15.2	120	0.0	7.6
964	Inc. 364 (C64)	6,072	47.8	22.42	39.9	13.53	13.3	111	0.0	7.6
SP6822-0	Lot 6519	4,027	63.5	14.60	57.3	13.74	15.4	119	0.6	8.4
Mean		8,036	33.9	26.29	28.8	15.14	8.0	117	0.4	6.1
LSD (.05)		1,322	10.2	3.81	8.6	0.69	5.5	8.6	NS	0.7
C. V. (%)		16.60	30.4	14.60	30.2	4.60	69.2	7.4	311.2	12.0
F value for varieties		12.0**	10.4**	9.6**	11.6**	13.4**	4.8**	3.3**	1.7 NS	24.6**
F value for virus		480.9**		585.2**		183.1**		0.6 NS	4.8 NS	
F value for variety x virus		6.4**		7.5**		4.5**		1.2 NS	1.7*	

TEST 2281-NONINOCULATED. YELLOWS & PERFORMANCE EVALUATION OF O.P. SOURCES & THEIR ADV. POPULATIONS, SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
8 varieties and 2 virus treatments
1-row plots, 37 ft. long

Planted: March 12, 1981
Noninoculated1/
Harvested: October 21, 1981

Variety2/	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/ 100' Number	Root Rot Percent	Bolting Percent
Y023	Inc. Y923	11,556	35.16	16.50	111	0.4	0.3
915	Inc. 915	12,657	39.03	16.23	129	0.5	0.0
Y030	Inc. Y930	11,230	35.00	16.04	122	1.2	0.0
968	Inc. 468	10,901	35.64	15.32	128	1.1	0.0
Y026	Inc. Y926	11,925	34.15	17.49	114	1.5	0.0
959	Inc. 959	11,027	35.48	15.53	123	0.8	0.0
E037	Inc. E937	10,107	30.43	16.61	118	0.2	0.0
Y009	Inc. US 22/3	11,129	33.37	16.66	128	0.8	2.4
Mean		11,317	34.78	16.30	122	0.8	0.3
LSD (.05)		955	2.19	0.70	11.5	NS	0.8
C. V. (%)		8.4	6.2	4.3	9.4	181.6	227.7
F value		5.1**	9.9**	7.8**	2.8*	0.7 NS	9.5**

1/ The BYV-BWYV inoculated performance and % loss data are summarized on the following page.

2/ 915 = Inc. US 15. Y023 = C_4 US 15. 968 = Inc. US 75. Y030 = C_5 US 75. 959 = Inc. US 56/2. Y026 = C_4 US 56/2. E037 = C_{11} US 75. Selection was for resistance to virus yellows but sugar yield was the primary selection criterion.

TEST 2281-BYV-BWYV INOCULATED. YELLOWS & PERFORMANCE EVALUATION OF O.P. SOURCES & THEIR ADV. POPULATIONS, SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
8 varieties and 2 virus treatments
1-row plots, 37 ft. long

Planted: March 12, 1981
BYV-BWYV Inoculated: May 20, 1981
Harvested: October 21, 1981

		Sugar Yield		Beet Yield		Sucrose		Beets/	Root	Yellows	
Variety	Description	Inoc.	Loss	Inoc.	Loss	Inoc.	Loss	100'	Rot	Score	Bolting
		Lbs/A	%	T/A	%	%	%	Number	%		%
Y023	Inc. Y923	7,629	33.2	25.94	25.3	14.72	10.8	116	0.3	6.3	0.0
915	Inc. 915	5,783	53.9	21.39	45.1	13.49	16.6	127	0.0	7.5	0.0
Y030	Inc. Y930	6,318	43.5	21.91	37.4	14.40	10.1	121	0.3	6.0	0.0
968	Inc. 468	5,559	48.4	20.93	40.9	13.26	13.1	129	0.2	7.3	0.0
Y026	Inc. Y926	7,280	38.7	22.81	32.6	15.91	9.1	113	0.4	6.0	0.0
959	Inc. 959	6,266	41.3	22.40	35.6	13.99	9.5	124	0.6	7.3	0.0
E037	Inc. E937	7,537	25.5	24.59	19.6	15.34	7.5	123	0.0	4.3	0.0
Y009	Inc. US 22/3	5,562	49.9	19.33	42.0	14.36	13.6	118	0.0	7.3	4.6
Mean		6,492	41.8	22.41	34.8	14.43	11.3	121	0.2	6.47	0.6
LSD (.05)		754	8.9	2.12	7.0	0.73	NS	9.3	NS	0.64	0.7
C. V. (%)		11.5	21.0	9.4	19.9	5.0	57.8	7.6	332.0	9.9	120.9
F value for varieties		10.9**	9.0**	7.9**	12.6**	12.0**	1.6 NS	2.6*	0.7 NS	23.3**	43.8**
F value for virus		232.5**		150.0**		130.9**		0.1 NS	18.1**		
F value for varieties x virus		7.5**		12.1**		1.5 NS		0.8 NS	0.5 NS		

TEST 1481-SULFUR. EVALUATION OF POWDERY MILDEW RESISTANT SELECTIONS
SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
8 varieties and 2 sulfur treatments
1-row plots, 30 ft. long

Planted: February 23, 1981
Sulfur-PM controlled1/
Harvested: October 8-9, 1981

Variety3/	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	PM Score2/
		Pounds	Tons	Percent	Number	Percent	9/10
Y031	NB Y831E	11,471	34.56	16.56	127	1.0	1.6
Y041	NB Y841	11,278	33.91	16.61	129	0.0	0.6
Y046	NB Y846	10,963	32.56	16.79	124	0.0	1.0
F79-36	79377 (C36)	9,611	30.40	15.81	127	0.0	3.0
PM-8	435-8A-1-2	9,383	28.52	16.43	124	0.0	1.4
PM-3	90-1, 20, 28	9,253	28.12	16.43	108	0.0	1.5
PM-1	22-9, 13, 16	8,985	27.68	16.23	131	0.0	1.0
PM-2	22-7, 8	8,976	27.99	16.01	130	0.0	1.1
Mean		9,990	30.47	16.36	125	0.1	1.4
LSD (.05)		763	2.08	0.41	11.5	0.5	1.1
C. V. (%)		7.6	6.8	2.5	9.1	392.3	79.6
F value		15.8**	15.1**	5.2**	3.2**	4.2**	3.3**

1/ Sprayed with sulfur for powdery mildew control on 7/22, 7/31, and 9/1. About 10 lbs/A wettable sulfur per application. Uncontrolled treatments summarized on following page.

2/ PM scored from 0 (no disease) to 9 (100% leaf area covered). Severity of PM was light and occurred late. Reliability of this test is fair.

3/ Y031, Y041, and Y046 are multigerm, O.P. lines. PM-1, -2, -3, -8 are multigerm, O.P. lines similar to C36 but reselected for resistance to powdery mildew.

TEST 1481-NO SULFUR. EVALUATION OF POWDERY MILDEW RESISTANT SELECTIONS
SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
8 varieties and 2 sulfur treatments
1-row plots, 30 ft. long

Planted: February 23, 1981
PM not controlled
Harvested: October 8-9, 1981

Variety	Description	Sugar Yield No Sulfur	Sugar Yield Loss	Beet Yield No Sulfur	Beet Yield Loss	Sucrose No Sulfur	Sucrose Loss	Beets/ 100'	Root Rot	PM Score
		Lbs/A	%	Tons/A	%	%	%	Number	%	9/10
Y041	NB Y841	11,255	-0.2	34.62	-2.2	16.19	2.4	124	0.4	3.1
Y046	NB Y846	10,876	1.2	32.40	0.6	16.69	0.6	128	0.0	4.3
Y031	NB Y831E	10,440	9.1	32.20	6.8	16.13	2.7	129	0.0	6.3
PM-3	90-1, 20, 28	8,866	4.3	27.27	3.2	16.26	1.1	112	0.0	3.8
F79-36	79377	8,754	8.3	28.59	5.6	15.36	2.8	132	0.0	6.6
PM-8	435-8A-1-2	8,741	6.7	27.45	3.8	15.91	3.1	127	0.0	5.0
PM-2	22-7, 8	8,719	2.3	27.50	1.4	15.85	1.0	138	0.0	5.0
PM-1	22-9, 13, 16	8,433	6.0	26.87	2.6	15.64	3.5	135	0.0	4.3
Mean		9,510	4.7	29.61	2.7	16.00	2.2	128	0.05	4.8
LSD (.05)		1,007	NS	2.61	NS	0.51	NS	9	NS	1.2
C. V. (%)		10.5	216.5	8.7	329.8	3.2	170.1	7.1	800.0	24.0
F value for varieties		10.5**	0.9 NS	10.7**	0.8 NS	5.2**	0.7 NS	6.2**	1.0 NS	8.7**
F value for treatments		3.1 NS		1.5 NS		6.0*		0.5 NS	0.8 NS	46.3**
F value for varieties x trtmts		0.9 NS		1.0 NS		0.7 NS		0.6 NS	3.4*	1.7 NS

TEST 1581-SULFUR. EFFECTS OF POWDERY MILDEW ON YIELD
SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
8 varieties and 2 sulfur treatments
2-row plots, 30 ft. long

Planted: February 26, 1981
Sulfur-PM controlled1/
Harvested: October 6 & 8, 1981

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	PM Score2/	
		Pounds	Tons	Percent	Number	Percent	8/30	9/10
Y941H8	F70-546H3 x Y841	11,159	32.63	17.07	138	0.3	1.3	2.4
Y031HL7	8755H0 x F79-31	11,092	32.94	16.82	130	0.5	1.5	2.5
E037H8	F78-546H3 x E937 (C37)	10,632	32.71	16.25	129	0.2	2.9	4.9
US H11	546H3 x F78-36 (80096)	10,581	32.84	16.17	134	0.3	3.1	4.6
Y052H8	F78-546H3 x Y952	10,329	31.61	16.34	136	0.5	1.8	2.9
Y031H8	F78-546H3 x F79-31	10,301	30.60	16.85	135	0.3	1.9	2.5
Monoricca	Hilleshog (Rec'd. 2/80)	10,183	28.38	17.91	139	0.2	1.4	1.4
HH27	Holly (Rec'd. 2/79)	9,747	28.86	16.86	142	0.0	1.4	1.4
Mean		10,503	31.32	16.79	135	0.3	1.7	2.8
LSD (.05)		NS	2.79	0.62	6.5	NS	0.5	1.2
C. V. (%)		9.9	8.80	3.60	4.8	221.8	30.0	43.7
F value		1.6 NS	3.6**	6.8**	4.0**	0.6 NS	31.8**	9.1**

1/ Sprayed with sulfur for powdery mildew control on 7/22, 7/31, and 9/1. About 10 lbs/A wettable sulfur per application. Uncontrolled treatments summarized on following page.

2/ PM scored from 0 (no disease) to 9 (100% leaf area covered). Severity of PM was only moderate and occurred relatively late. Control with sulfur was only partial. Reliability of this test is only fair.

TEST 1581-NO SULFUR. EFFECTS OF POWDERY MILDEW ON YIELD
SALINAS, CALIFORNIA, 1981

Split-block with 8 replications
8 varieties and 2 sulfur treatments
2-row plots, 30 ft. long

Planted: February 26, 1981
PM not controlled
Harvested: October 6 & 8, 1981

Variety	Description	Sugar Yield No Sulfur	Sugar Yield Loss	Beet Yield No Sulfur	Beet Yield Loss	Sucrose No Sulfur	Sucrose Loss	Beets/ 100'	Root Rot	PM Score	
		Lbs/A	%	Tons/A	%	%	%	Number	%	8/30	9/10
Y031HL7	8755H0 x F79-31	10,519	4.8	30.93	6.1	17.04	-1.4	137	0.3	5.1	6.9
Monoricca	Hilleshog (Rec'd. 2/80)	10,048	0.6	28.02	0.8	17.95	-0.3	140	0.5	4.0	3.8
Y941H8	F70-546H3 x Y841	9,917	10.7	30.13	7.8	16.49	3.3	137	0.5	5.1	6.4
Y052H8	F78-546H3 x Y952	9,869	4.0	30.43	3.7	16.26	0.4	139	0.2	5.8	7.3
Y031H8	F78-546H3 x F79-31	9,839	3.9	29.38	3.7	16.80	0.2	136	0.0	5.9	6.9
E037H8	F78-546H3 x E937 (C37)	9,679	8.5	30.18	7.5	16.02	1.2	138	0.2	7.0	7.9
US H11	546H3 x F78-36 (80096)	9,530	9.6	30.83	6.1	15.45	4.1	143	0.6	7.5	7.9
HH27	Holly (Rec'd. 2/79)	9,443	2.6	28.34	1.8	16.64	1.1	142	0.0	2.4	3.8
Mean		9,855	5.6	29.78	4.7	16.58	1.1	139	0.3	5.3	6.3
LSD (.05)		NS	NS	NS	NS	0.49	NS	NS	NS	0.7	1.1
C. V. (%)		9.6	147.9	8.8	143.2	2.9	389.3	5.9	228.7	13.0	17.3
F value for varieties		1.0 NS	1.5 NS	1.4 NS	1.2 NS	18.4**	1.5 NS	0.7 NS	1.1 NS	43.7**	18.7**
F value for treatments		6.0*		8.1*		1.1 NS		0.8 NS	0.0 NS	136.9**	120.7**
F value for varieties x trtmts.		1.5 NS		1.2 NS		1.7 NS		1.0 NS	0.9 NS	5.7**	2.4*

Table 1: Sugarbeet root toughness comparisons for high and low fiber root selections and their hybrids, 1981

Line or Hybrid No.	Description	Test 1, Seeded 12/18/80 — Roots Probed (Scale of 1 to 28+ lbf)[4/] No. Roots N	Pop. Mean[2/] lbf	Roots 28+ 28+/N No.	%	Bolt. %	Test 2, Seeded 3/11/81 — Roots Probed (Scale of 1 to 28+ lbf) No. Roots N	Pop. Mean lbf	Roots 28+ 28+/N No.	%
936H72SS	718H0 x 936SS	164	17.07a[3/]	2	1.2	1.9	171	15.74a	0	0.0
936H8SS	546H3 x F78-36SS	167	18.34b	3	1.8	0.0	186	16.55ab	1	0.5
F78-36	Inc. F77-36	151	19.14bc	10	6.6	1.3	175	17.78bcd	9	5.1
936SS	Inc. F78-36SS sel.[1/]	159	19.60cde	26	16.3	0.0	157	17.26bcd	4	2.5
936H8ST	546H3 x F78-36ST	165	20.19de	18	10.9	5.1	171	18.57de	3	1.8
936H72ST	718H0 x 936ST	151	20.39e	23	15.2	7.5	170	18.13dc	11	6.5
936ST	Inc. F78-36ST sel.	132	22.70f	44	35.8	2.6	161	19.55e	22	13.7
Group Means			19.63			2.6		17.65		
Y940SS	Inc. Y740SS sel.	145	15.67a	0	0.0	1.4	182	15.12a	2	1.1
Y940H72SS	718H0 x Y940SS	159	15.99a	2	1.2	3.4	166	16.00ab	1	0.6
Y940H8SS	546H3 x Y940SS	151	16.41ab	1	0.7	0.0	194	15.87ab	0	0.0
Y740	Inc. Y640	153	17.20b	2	1.3	1.2	175	17.11cd	2	1.1
Y940H72ST	718H0 x Y940ST	154	17.34b	2	1.3	2.0	172	16.53bc	1	0.6
Y940H8ST	546H3 x Y940ST	154	18.63c	5	3.2	1.3	158	17.67d	5	3.2
Y940ST	Inc. Y740ST sel.	153	21.42d	35	22.9	6.0	165	19.41e	23	13.9
Group Means			17.52			2.2		16.82		
Y931H8SS	546H3 x Y931SS	138	16.94a	0	0.0	0.8	191	15.36a	0	0.0
Y931H72SS	718H0 x Y931SS	149	17.88ab	0	0.0	0.7	135	16.32b	0	0.0
Y931SS	Inc. Y731ESS sel.	151	18.47ab	3	2.0	0.6	165	17.48c	0	0.0
Y731	Inc. Y631E	150	18.82ab	9	6.0	1.4	189	17.92d	2	1.1
Y931H8ST	546H3 x Y931ST	164	19.69b	8	4.9	0.0	175	18.07d	3	1.7
Y931ST	Inc. Y731EST sel.	165	21.68c	29	17.6	0.6	170	19.15e	10	5.9
Group Means			18.91			0.7		17.38		
Test Means			18.67			1.87		17.28		
LSD (.05)			1.26			3.27		0.95		
C. V. (%)			4.8			123.0		3.90		
F value			19.03**			3.25*		15.67**		

1/ SS = Low fiber (soft) selections. ST = High fiber (tough) selections.
2/ Root probes were made with an Effegi penetrometer equipped with a 1x10 mm blade (10 sq. mm area) x 2.54 cm 1.
3/ Test means followed by a common letter are not significantly different at the 5% level - DMR Test.
4/ lbf = pound-force.

Table 1: (Continued)

Line or Hybrid No.	Test 1, Seeded 12/18/80 12-14	15-17	18-20	21-23	24-26	27-28+	12-20 Classes Total Probed %	Test 2, Seeded 3/11/81 12-14	15-17	18-20	21-23	24-26	27-28+	12-20 Classes Total Probed %
936H72SS	43	59	34	20	6	2	82.9	66	60	37	8	0	0	95.3
936H8SS	22	47	61	25	9	3	77.8	53	63	56	11	2	1	92.5
F78-36	26	27	46	27	15	10	65.6	43	50	46	16	11	9	79.4
936SS	22	45	37	14	15	26	65.4	34	61	38	14	6	4	84.7
936H8ST	8	31	65	28	15	18	63.0	19	53	55	25	16	3	74.3
936H72ST	16	29	40	26	17	23	56.3	40	45	38	27	9	11	72.3
936ST	10	11	25	25	17	44	34.8	24	36	43	24	12	22	64.0
Group Means							63.7							80.4
Y940SS	59	50	28	7	1	0	94.5	97	50	29	4	0	2	96.7
Y940H72SS	57	60	33	7	0	2	94.3	63	54	41	4	3	1	95.2
Y940H8SS	48	55	31	14	2	1	88.7	77	64	39	13	1	0	92.8
Y740	37	55	35	16	8	2	83.0	41	64	44	17	7	2	85.1
Y940H72ST	41	44	38	21	8	2	79.9	53	61	40	14	3	1	89.5
Y940H8ST	21	47	40	28	13	5	70.1	35	50	41	21	6	5	79.7
Y940ST	6	32	33	30	17	35.	46.4	27	43	38	18	16	23	65.4
Group Means							79.6							86.3
Y931H8SS	31	46	49	10	2	0	91.3	82	74	30	5	0	0	97.4
Y931H72SS	26	47	38	32	6	0	74.5	43	44	36	10	2	0	91.1
Y931SS	27	35	41	35	10	3	68.2	30	57	49	24	5	0	82.4
Y731	22	33	50	28	8	9	70.0	24	66	63	26	8	2	80.9
Y931H8ST	11	30	61	42	12	8	62.2	33	46	55	27	11	3	76.6
Y931ST	6	24	43	30	33	29	44.2	22	42	46	37	13	10	64.7
Group Means							68.4							82.2
Test Means							70.6							83.0

Frequency Distribution of Root Toughness (lbf)

Table 2: Sugarbeet root toughness comparisons for high and low fiber root selections and their hybrids, 1982

Line or Hybrid No.	Description1/	Roots Probed (Scale of 1 to 28+ lbs Force)4/			
		No. Roots	Pop. Mean2/	Roots 28+ 28+/N	
		N	(lb F)	No.	%
F78-36	Parent (P)	190	19.28cd3/	15	7.9
036SS	Soft sel. (SS)	169	19.94de	20	11.8
936H8SS	546H3 x SS (TX)	195	18.36bc	9	4.6
936H72SS	718H0 x SS	178	16.79a	4	2.2
036ST	Tough sel. (ST)	175	21.06fg	32	18.3
936H8ST	546H3 x ST	184	21.31fg	32	17.4
936H72ST	718H0 x ST	166	21.85g	37	22.3
US H11	546H3 x P	199	20.43ef	21	10.6
E936H72	718H0 x P	188	18.12b	6	3.2
Group Mean			19.68		
SY131	Parent (P)	141	17.87a	0	0.0
SY131SS	Soft sel. (SS)	173	16.81a	2	1.2
SY131H8SS	546H3 x SS (TX)	177	17.94a	5	2.8
SY131H72SS	718H0 x SS	167	16.89a	5	3.0
SY131ST	Tough sel. (ST)	157	21.62c	29	18.5
SY131H8ST	546H3 x ST	175	21.59c	37	21.1
SY131H72ST	718H0 x ST	157	19.55b	13	8.3
SY131H8	546H3 x P	159	17.77a	3	1.9
SY131H72	718H0 x P	135	17.76a	0	0.0
Group Mean			18.64		
SY140	Parent (P)	166	17.57b	0	0.0
Y040SS	Soft sel. (SS)	181	15.59a	1	0.6
Y940H8SS	546H3 x SS (TX)	183	17.70b	1	0.5
Y940H72SS	718H0 x SS	179	16.64bc	3	1.7
Y040ST	Tough sel. (ST)	190	20.46d	14	7.4
SY140H8ST	546H3 x ST	200	20.59d	19	9.5
SY140H72ST	718H0 x ST	194	20.38d	25	12.9
SY140H8	546H3 x P	194	19.47d	8	4.1
SY140H72	718H0 x P	173	19.18d	16	9.2
Group Mean			18.62		
Test Mean			18.94		
LSD (.05)			0.93		
C. V. (%)			3.48		
F value			28.83**		

1/ P = Parent, SS = Low fiber (soft sel.), ST = High fiber (tough sel.), TX = Test cross.

2/ Root probes made with an Effegi penetrometer equipped with a 1 x 10 mm blade (10 sq. mm area) x 2.54 cm long.

3/ Test means followed by a common letter are not significantly different at the 5% level - DMR Test.

4/ lb F = pound-force.

5/ Test harvested 11/16/82.

Table 2: (Continued)

Line or Hybrid No.	Frequency Distribution of Root Toughness - Pounds Force (lb F) Test Seeded 4/30/82[5/] 12-14	15-17	18-20	21-23	24-26	27-28+	12-20 Classes Total Probed %
F78-36	16	60	52	26	16	20	67.4
036SS	10	59	40	18	14	28	64.4
936H8SS	28	69	49	28	9	12	74.9
936H72SS	48	65	44	15	3	3	88.2
036ST	12	36	39	33	18	37	49.7
936H8ST	16	33	36	36	20	43	46.2
936H72ST	8	22	44	30	21	41	44.6
US H11	14	42	58	34	23	28	57.3
E936H72	43	55	39	25	15	11	72.9
Group Mean							62.8
SY131	12	56	52	16	4	1	85.1
SY131SS	33	83	41	11	3	2	90.7
SY131H8SS	18	72	59	16	7	5	84.2
SY131H72SS	54	58	28	16	3	8	83.8
SY131ST	9	21	42	26	26	33	45.9
SY131H8ST	14	26	38	33	19	45	44.6
SY131H72ST	18	45	33	30	14	17	61.1
SY131H8	25	58	45	15	13	3	80.5
SY131H72	22	49	36	20	6	2	79.3
Group Mean							72.8
SY140	18	68	57	20	3	0	86.1
Y040SS	76	70	24	7	3	1	93.9
Y940H8SS	24	66	71	15	5	2	88.0
Y940H72SS	52	67	44	10	3	3	91.1
Y040ST	4	38	70	36	22	20	58.9
SY140H8ST	14	38	53	45	22	28	52.5
SY140H72ST	14	44	57	27	18	34	59.3
SY140H8	8	45	80	41	9	11	68.6
SY140H72	18	57	45	23	11	19	69.4
Group Mean							74.2

Table 3: Yield comparisons for high and low fiber root selections, their parents and test cross hybrids, 1981 and 1982

Line or Hybrid No.	Description[1]	Test Seeded 4/30/82[2] Acre Yield Sugar Pounds	Beets Tons	Sucrose Percent
F78-36	Parent (P)	9,037abc[3]	29.44ab	15.35cd
036SS	Soft sel. (SS)	8,724a	28.12a	15.53d
936H8SS	546H3 x SS (TX)	10,279c	33.87cd	15.19abcd
936H72SS	718H0 x SS	10,108abc	35.16d	14.40a
036ST	Tough sel. (ST)	8,839ab	29.90abc	14.81abcd
936H8ST	546H3 x ST	9,320abc	31.69abcd	14.70abc
936H72ST	718H0 x ST	10,015abc	34.44cd	14.58abc
US H11	546H3 x P	9,080abc	29.81abc	15.25bcd
E936H72	718H0 x P	10,233bc	34.08cd	14.99abcd
Group Mean		9,513	31.83	14.97
SY131	Parent (P)	10,681bc	32.39abc	16.45e
SY131SS	Soft sel. (SS)	9,683abc	30.06ab	16.08de
SY131H8SS	546H3 x SS (TX)	8,784a	29.20a	15.04abc
SY131H72SS	718H0 x SS	9,756abc	33.16abc	14.66ab
SY131ST	Tough sel. (ST)	10,377abc	33.71abc	15.39bcd
SY131H8ST	546H3 x ST	9,206ab	31.48abc	14.63ab
SY131H72ST	718H0 x ST	9,901abc	34.69bc	14.26a
SY131H8	546H3 x P	11,036c	34.85bc	15.81cde
SY131H72	718H0 x P	10,779bc	35.57c	15.19abc
Group Mean		10,022	32.79	15.27
SY140	Parent (P)	10,323de	32.24abc	16.00d
Y040SS	Soft sel. (SS)	10,845e	35.17c	15.44bc
Y940H8SS	546H3 x SS (TX)	10,165cde	33.09bc	15.36bc
Y940H72SS	718H0 x SS	10,522de	35.08c	14.99ab
Y040ST	Tough sel. (ST)	9,092ab	30.25ab	15.04ab
SY140H8ST	546H3 x ST	8,881a	29.60a	15.03ab
SY140H72ST	718H0 x ST	9,863bcd	33.91c	14.58a
SY140H8	546H3 x P	10,131cde	32.39abc	15.63cd
SY140H72	718H0 x P	9,295abc	31.99abc	14.53a
Group Mean		9,902	32.63	15.17
Test Mean		9,812	32.41	15.13
LSD (.05)		1,177	3.75	0.68
C. V. (%)		8.52	8.20	3.20
F value		2.70**	2.75**	5.08**

1/ P = Parent, SS = Soft selection, ST = Tough selection, and TX = Test cross.
2/ Plots harvested 11/16/82, 11/9/81 and 11/5/81.
3/ Test means followed by common letter are not significantly different at the 5% level - DMR Test.

Table 3: (Continued)

Line or Hybrid No.	Test 1 Seeded 12/18/80 Acre Yield Sugar Pounds	Beets Tons	Sucrose Percent	Test 2 Seeded 3/11/81 Acre Yield Sugar Pounds	Beets Tons	Sucrose Percent
F78-36	12,781a	39.06a	16.32a	13,027ab	42.70a	15.28ab
036SS	13,908ab	42.45b	16.28a	12,292a	40.73a	15.10ab
936H8SS	18,144c	52.34d	17.39a	14.380bc	45.85abc	15.71b
936H72SS	17,662c	54.23d	16.25a	14,370bc	49.23c	14.60a
036ST	15,148b	45.88bc	16.49a	13,148ab	43.19ab	15.19ab
936H8ST	18,337c	52.79d	17.43a	15,810c	50.29c	15.76b
936H72ST	17,713c	53.03d	16.71a	14,764bc	48.92bc	15.08ab
US H11	--	--	--	--	--	--
E936H72	--	--	--	--	--	--
Group Mean	16,242	48.54	16.69	13,970	45.84	15.24
SY131	17,203a	48.49a	17.74bc	15,133ab	45.63a	16.59c
SY131SS	17,224a	48.86a	17.63bc	14,052a	43.97a	16.04bc
SY131H8SS	17,213a	51.50a	16.69a	14,692ab	46.89a	15.66ab
SY131H72SS	18,332a	53.78a	17.05ab	15,775b	52.26b	15.10a
SY131ST	19,411a	53.74a	18.09c	14,744ab	45.51a	16.19bc
SY131H8ST	18,082a	51.05a	17.73bc	15,200ab	46.39a	16.39c
SY131H72ST	--	--	--	--	--	--
SY131H8	--	--	--	--	--	--
SY131H72	--	--	--	--	--	--
Group Mean	17,910	51.24	17.49	14,933	46.77	15.99
SY140	18,108cde	54.69bc	16.57a	13,987a	45.87a	15.29a
Y040SS	17,588cd	53.72bc	16.36a	15,580b	50.16abc	15.53a
Y940H8SS	15,978ab	48.13a	16.61a	14,746ab	47.88ab	15.40a
Y940H72SS	18,904de	58.16c	16.31a	16,188b	53.42c	15.19a
Y040ST	15,204a	48.40a	15.71a	14,856ab	48.91abc	15.20a
SY140H8ST	16,795bc	50.93ab	16.53a	15,913b	51.96bc	15.32a
SY140H72ST	19,565e	58.85c	16.68a	15,248ab	50.68bc	15.05a
SY140H8	--	--	--	--	--	--
SY140H72	--	--	--	--	--	--
Group Mean	17,449	53.27	16.40	15,217	49.84	15.28
Test Mean	17,165	51.00	16.83	14,696	47.52	15.48
LSD (.05)	1,935	5.72	1.18	1,484	4.86	0.89
C. V. (%)	8.00	7.90	5.00	7.10	7.20	3.10
F value	6.68**	5.62**	2.30**	3.79**	4.00**	4.49**

SUGARBEET RESEARCH

1982 Report

Section B

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CONTENTS

Page

I. EXPERIMENTAL FIELD TRIALS by J. C. Theurer and D. L. Doney

A. Commercial Variety Test B2

B. Combining Ability Test for Curly Top Inbreds B3

II. SELECTION OF 60-DAY OLD BEETS BASED ON ROOT/TOP RATIO AND ROOT WEIGHT by J. C. Theurer. B6

III. PHYSIOLOGICAL SELECTION by D. L. Doney. B7

IV. GROWTH ANALYSIS by J. C. Theurer

Root/top Partitioning Among Inbreds and Their Diallel Cross Hybrids B18

V. INSECT STUDIES

Selection for Plant Resistance to the Sugarbeet Root Maggot by J. C. Theurer, C. C. Blickenstaff, and G. G. Mahrt B23

VI. DISEASE STUDIES

Comparison of Sugarbeet and Several Weeds as Hosts for Beet Leafhopper and Beet Curly Top Virus by D. L. Mumford and D. L. Doney. B31

VII. POTENTIAL ALCOHOL FUEL RESEARCH by J. C. Theurer and D. L. Doney

A. National Cooperative Fuel Beet Trials B34

B. Intermountain Fuel Beet Field Trials. B43

VIII. PHYSIOLOGY-BIOCHEMISTRY

Relationship Between Sucrose Accumulation and Taproot Enzyme Activities by Roger E. Wyse. . . B66

I. EXPERIMENTAL FIELD TRIALS

J. C. Theurer and D. L. Doney

Agronomic Data

Soil Types:	North Farm - Logan, Utah - silty loam Aberdeen Research Station, Idaho - clay loam
Fertilizer:	950 lbs/acre of 16-20-0
Herbicides:	No chemical treatment was made for weed control in 1982.
Planting Dates:	North Farm, Logan - May 13 Aberdeen, Idaho - April 22
Thinning Dates:	North Farm - June 16 to 18 Aberdeen - May 18 to 20, 24 to 26
Irrigations:	Sprinkler irrigated at both locations until two weeks prior to harvest
Harvest Dates:	North Farm - October 12 to 15 Aberdeen - October 18 to 21
Harvesting Procedures:	Tops were removed by beating twice with a roto-beater then dug with a two-row harvester. Beets/plot were counted as they went into a weighing basket on the harvester. Two 10-beet samples were taken at random from each two-row plot for sugar analysis. All beets in each plot were weighed to determine root yield.

A. COMMERCIAL VARIETY TEST

Eight commercial cultivars and 19 experimental varieties were compared in a field test at Aberdeen, Idaho, in 1982. Individual plots were two rows wide, 56 cm apart, and 11 m long, and they were planted in six replications of a randomized block design. A late spring frost killed some of the early germinating plants, and injured others, but in spite of the adverse climatic conditions at the time of germination, we obtained a relatively good stand. Very little evidence of curly top was noted in the test.

Mean sugar yield, root yield, sucrose percentage, and impurity factors are listed in Table 1. GWH149 had significantly greater sugar yield than all entries except the experimental variety J141. This line had L29 and L38 in its parentage. Fourteen of the new experimental varieties were equal in sugar yield to WS76, the second highest sugar yield variety in the test. Twelve experimentals were significantly higher in sugar yield than Hybrid 8, the lowest yielding variety in the test. The variety g241 had hybrid of C16 X g241 were highest in root yield and lowest in sugar percentage. Fourteen of the

experimental varieties were not significantly different than GWH149, the commercial variety with the highest root yield. J321 and J141 had excellent sucrose percentage compared to the commercials. Variety g241, which was selected from the Ames Collection of Beta had significantly the poorest quality of all entries as noted by the high impurity Amino N, Na, and K values. It also transmitted poor quality to its hybrid with C16. The other experimental varieties had impurity indices within the same range as the commercial cultivars.

Table 1. Mean sugar yield, root yield, sucrose percentage, Amino N, Na, K, and impurity index for commercial cultivars and experimental varieties at Aberdeen, Idaho, 1982.

Code/Variety	Sugar yield t/ha	Root weight t/ha	Sucrose %	Amino N ppm	Na ppm	K ppm	Impurity Index
1. GWH149	11.99	76.23	15.7	488	335	2243	745
2. WS76	10.17	70.17	14.5	553	485	2016	851
3. Beta 9421	9.76	71.97	13.6	497	588	2602	1013
4. ACH130	8.98	67.71	13.3	582	792	2593	1148
5. Hybrid 8	8.17	58.29	14.1	557	509	2072	891
6. HH7	9.52	65.69	14.5	493	493	1950	798
7. USH20	8.91	70.40	12.7	572	704	2075	1051
8. USH11	9.56	70.85	13.3	453	636	2331	965
9. J193	10.35	77.80	13.3	544	620	2209	1000
10. J195	9.87	74.66	13.2	513	560	2393	998
11. J198	9.65	67.71	14.3	515	541	2218	889
12. J201	9.82	67.93	14.3	481	530	2260	864
13. J203	9.14	74.43	12.3	608	703	2454	1195
14. J205	7.52	58.29	12.9	593	765	2043	1084
15. J115	9.88	67.71	14.6	492	588	2137	845
16. J321	8.90	59.41	15.0	534	446	2075	816
17. J137	10.16	75.33	13.5	569	737	2435	1074
18. J305	9.87	69.05	14.3	510	551	2037	855
19. J121	9.93	71.52	13.9	480	576	2397	932
20. J359	8.11	57.84	14.0	553	577	2014	907
21. J160	8.39	63.00	13.3	490	558	2002	906
22. J141	11.28	75.33	15.0	538	639	2337	901
23. J139	9.90	65.91	14.9	555	510	1975	837
24. C16 X g241	8.10	81.61	9.9	509	859	2710	1509
25. g241	7.16	82.73	8.7	523	986	2893	1902
26. L53 X g237	10.18	76.23	13.4	588	841	2104	1065
27. 416 X g237	9.93	71.30	13.9	466	680	2183	903
Mean	9.45	69.95	13.6	529	623	2251	998
LSD 0.05	1.38	8.79	1.10	91.0	260	318	190
C. V.	12.8	11.0	7.1	15.1	36.5	12.4	16.7

B. COMBINING ABILITY TEST FOR CURLY TOP INBREDS

The combining ability of nine high curly top resistant and three moderate curly top resistant inbreds (CT53.35, L11, and L38) was evaluated in a replicated field trial at Aberdeen. Individual plots were two rows, 56 cm apart, and 11 m long. There were six replicates of each entry in the test. The female CMS parents of USH20 and USH10 were used as testcross parents. WS76, GWH149, and *Beta* 9421 were included in the test as checks. The sugar yield, root yield, sucrose percentage, impurity index, and a score for curly top are given in Table 2. GWH149 had the highest sugar yield of the entries in the test. L38 crosses were equal to GWH149 for total sugar, while all others showed significantly lower yields. One or more crosses with CT53.35, CT99, CT51, E136m, L34, L57, L11, and L38 were not different in sugar yield from that of WS76 or *Beta* 9421. L34 showed significantly better combining ability for sugar yield when crossed to USH20♀ than to USH10. Combining ability differences observed between females with other pollinators were not significant. L56 had significantly higher root yield with USH10♀ than with USH20♀. L34 showed the opposite result. The moderately resistant lines, L38 and L11, had higher root yield than the resistant entries and were not significantly different from the high yielding GWH149 commercial. The high curly top resistant inbreds were significantly lower in root yield than GWH149; however, in general, they were equal in root yield to the other two checks. A similar relationship of curly top hybrids compared to the commercial varieties was observed for sucrose percentage. All of the entries were similar for impurity index with the exception of hybrids having L38 as a parent. This inbred had significantly higher combining ability for poor quality. The L34 inbred was released to the sugarbeet industry in 1981. Based on the results of this 1982 combining ability study, and the curly top rating of the inbreds and hybrids, it would appear that some of the other inbreds merit release in the near future.

Table 2. Mean sugar yield, root yield, sucrose percentage, Amino N, Na, K, and impurity index and curly top rating for new curly top inbreds, Aberdeen, Idaho, 1983.

Code/Variety	Curly top rating 1982 (0-9 scale)	Sugar yield t/ha	Root weight t/ha	Sucrose %	Amino N ppm	Na ppm	K ppm	Impurity Index
1. 20♀XCT1.36	2.0	9.34	65.47	14.3	494	472	2066	825
2. 10♀XCT1.36		8.87	59.64	15.1	526	331	2145	783
3. 20♀XCT53.35	3.5	9.92	67.48	14.7	505	519	2175	841
4. 10♀XCT53.35		10.55	68.38	15.4	585	335	2212	818
5. 20♀XL56	1.5	8.33	54.48	15.3	559	426	1829	770
6. 10♀XL56		9.62	64.57	14.9	507	415	2145	802
7. 20♀XCT99	1.5	9.70	64.12	15.1	568	563	1981	838
8. 10♀XCT99		10.64	71.30	14.9	993	434	1972	773
9. 20♀X37E4EL	1.5	9.16	59.41	15.4	493	340	1785	689
10. 20♀X37E2m	2.0	9.18	62.10	14.8	532	465	1841	784
11. 20♀XCT51	1.5	9.75	69.95	14.0	531	510	2152	895
12. 10♀XCT51		9.87	65.47	15.1	484	345	2122	758
13. 20♀X37EL36m	2.5	9.01	60.98	14.7	444	475	1875	745
14. 10♀X37EL36m		9.74	67.26	14.5	471	482	2191	822
15. 20♀XL34	2.5	10.45	71.30	15.2	489	488	1954	757
16. 10♀XL34		8.51	56.27	15.1	479	333	2081	740
17. 20♀XL57	2.0	8.59	61.21	14.0	480	500	1795	796
18. 10♀XL57		9.38	67.04	14.1	511	440	1918	817
19. 20♀XL11	3.5	11.09	72.87	15.2	520	588	2093	829
20. 20♀XL38	3.3	11.43	76.23	15.0	656	679	2650	1038
21. 10♀XL38		12.08	80.49	15.0	553	627	3243	1060
22. WS76	3.8	10.99	69.73	15.7	524	405	2206	775
23. GWH149	3.6	12.55	76.00	16.5	523	418	2266	755
24. Beta 9421	5.6	10.10	67.48	15.1	497	570	2285	844
25. 20♀	4.5							
Mean		9.97	66.59	15.0	517.9	465.5	2124.7	815.2
LSD 0.05		1.37	8.30	1.03	103	194	353	158
C. V.		12.0	10.9	6.0	17.5	36.4	14.5	17.0

II. SELECTION OF 60-DAY OLD BEETS BASED ON ROOT/TOP RATIO AND ROOT WEIGHT

J. C. Theurer

In 1980, five heterogeneous populations of sugarbeets were planted in block units of several rows 56 cm apart and 12 meters long. Plants were meticulously thinned to 30 cm between plants within the row. After 60 days growth in the field, the plants were classified for root/top (R/T) ratio and root weight. Competitive disease free plants exceeding one standard deviation for both R/T ratio and root weight were selected, potted up in 6-inch pots, placed in thermal induction, and subsequently into seed isolation units for seed increase. Sufficient seed was produced for three of the selections to make a comparison with their parental populations in a replicated field trial at Aberdeen in 1982.

The six entries in the test were planted in 2-row plots, 56 cm apart and 11 meters long. There were six replicates of each entry. Sugar yield, root weight, sucrose percentage, and quality factors are given in Table 1. Selection in population 37H22 was not effective for any of the characters measured. In the other two populations, 35F2 and 6F4, the selections had higher root weight and higher sugar yield. However, only sugar yield for population 6F4 was significantly greater for the selection versus the parent. There was no difference in sucrose content or impurity factors for any of the populations. Data suggest that there are differences between genotypes for potential selection in the field. However, even though the plants were uniformly spaced and meticulously thinned, and care given to selection blocks, it appears there is too much environmental variation present to make progress in selecting for plants with high R/T ratios in field plots.

Table 1. Sugar yield, root weight, sucrose percentage, amino N, Na, K content, and impurity index of selections versus parents in three populations of sugarbeets, Aberdeen, Idaho, 1982.

Entry	Sugar yield t/ha	Root weight t/ha	Sucrose %	Amino N ppm	Na ppm	K ppm	Impurity Index
37H22 Sel.	6.61	49.10	13.5	555	388	2016	892
37H22 Par.	6.66	50.22	13.3	552	327	1889	839
35F2 Sel.	9.70	75.56	13.0	492	820	2554	1117
35F2 Par.	9.11	69.50	13.1	457	723	2260	985
6F4 Sel.	8.57	57.17	15.0	452	615	2164	814
6F4 Par.	7.97	53.14	15.0	555	528	1852	810
LSD .05	.83	6.19	14.0	511	538	2120	890
C. V.	9.0	9.4	0.8	99	242	398	186

III. PHYSIOLOGICAL SELECTION

Devon L. Doney

A. Background

Past progress in increasing sugar production has been significant but slow. Reasons for this slow progress have been: 1) the negative correlation between root yield and sucrose content, 2) the biennial growth habit of sugarbeet making for long breeding cycles, and 3) high environment by genotype variation. If improvement is to be speeded up, these three constraints to potential breeding progress must be understood and overcome or at least minimized. The breeder must have sufficient knowledge about these constraints in order to manipulate them to his advantage.

Our research effort has been two-fold: 1) to investigate the physiological and genetic basis for the negative correlation between root yield and sucrose content, and 2) to develop fast, efficient selection techniques having high precision. We have determined that the negative correlation between root yield and sucrose content is due to the opposite effects of cell size on root yield and sucrose content. In addition, genetic differences in cell size are due largely to additive genes. Therefore, the additive genes that effect cell size are probably the same additive genes that affect root yield and sucrose content. This suggests that selection schemes for high root yield that capitalize on additive gene action are probably operating on the same additive genes for cell size and are the cause of much frustration to the breeder. Selection schemes should, therefore, be developed to utilize non-additive gene effects. We have developed both recurrent and reciprocal recurrent seedling selection procedures for sugarbeet. These breeding methods are designed to aid in simultaneously selecting for both types of gene action.

Sugarbeet roots differentiate into their genetically determined number of cambial rings at a very young age (when the root is 1.0 to 1.5 cm in diameter). From then on growth is cell division and cell expansion, taking place simultaneously in cell rings. The genetic identity of a sugarbeet plant has been attained by this time. Therefore, we should be able to measure important growth parameters in the seedling stage rather than waiting until harvest time. Effective selection in the seedling stage could greatly reduce the selection cycle. We have developed seedling selection methods that reduce the selection cycle by almost one-third. In addition, carefully controlled greenhouse procedures have been effective in reducing genotype by environmental variation.

The above developments have been utilized in developing selection criteria that will key on non-additive genetic variation or on indirect selection for root yield and sucrose content in the seedling stage. This past year several seedling selection parameters were evaluated in replicated field trials.

B. Selection for Hypocotyl Diameter (HD), Dry·Weight (DW), and Percent Dry Weight (% DW) in the Seedling Stage

These three seedling parameters have been tested to a limited extent in previous years. This year's tests conclude the evaluation of these seedling parameters as potential selection criteria.

The selections evaluated in this year's replicated field trials come from six different heterozygous populations. To initiate the selection process, each population was grown in an open-pollinated seed increase isolation. Seed was harvested from each plant (sib progeny) and progeny tested in the greenhouse for seedling hypocotyl diameter, dry weight yield, and root percent dry matter. Selections were based on the progeny tests. Steckling were produced from the remnant seed of the selected lines for seed increase the following year. Lines were mixed to produce the new selection population where more than one line was selected for a given parameter. The resultant seed increases or new selection populations were evaluated in replicated field trials in the summer of 1982. Only one selection for high hypocotyl diameter was selected from population h537 (Table 1).

Table 1. Root yield, % sucrose, and sucrose yield of a sib selection for high hypocotyl diameter (HD) and the parent population (h537).

Selection parameters	Gross sucrose Lbs/A	Root yield T/A	Sucrose %
High HD	7284	27.4	13.3
Parent (h537)	7804	30.1	12.9
LSD 0.05	1487	4.8	0.9

Past selection results for HD have generally shown HD selection to increase root yield and decrease percent sucrose. This selection appears to be just the reverse; i.e., reduced root yield and increased sucrose content. However, differences are not significant and the selection must be considered as a random selection from the parent population. This suggests that the environmental controls in this greenhouse progeny testing were insufficient to detect true genetic differences.

We rationalized that seedlings with small cells should be high in dry matter content and those with high total dry matter yield should yield the most sugar. A selection was made for seedling high total dry matter yield in population m39 (Table 2). This selection was not superior to the parent population but inferior in root yield and sucrose yield. This reduced yield may have been due to inbreeding depression. However, selection pressure for high dry matter yield in the seedling stage was not positive in this population.

Table 2. Sucrose yield, root yield, and % sucrose for a high dry matter yield seedling selection and the parent population, m39.

Selection parameter	Gross sucrose Lbs/A	Root yield T/A	Sucrose %
High dry matter yield	8388	30.7	13.7
Parent (m39)	9354	33.3	14.1
LSD 0.05	972	3.0	0.6

Selections for high dry weight and high percent dry weight were made in population h480 (Table 3). The high dry weight selections should have yielded more gross sugar and the high percent dry weight selections should have had a higher percent sucrose than the parent population. The selections for both seedling parameters were higher than the parent populations but the increases were not significant.

Table 3. Sucrose yield and % sucrose for selections for high seedling dry matter and % dry matter, respectively, and the parent population h480.

Selection parameter	Gross sucrose Lbs/A	Selection parameter	Sucrose %
High dry weight	6558	High % dry weight	12.7
Parent (h480)	6003	Parent (h480)	12.3
LSD 0.05	1063		0.9

Selections were made for hypocotyl diameter, dry weight, and percent dry weight in population h495 (Table 4). The high dry weight selections yielded the same sucrose as the parent; however, the high HD selections had significantly larger root yields than the parent. The high percent dry weight selections were significantly lower in sucrose content than the parent population. This result is similar to past results; i.e., high HD selections tend to increase root yield and decrease percent sucrose. It appears that the selection pressure for HD was greater than that for percent DW and masked genetic differences for sucrose content. This points out the difficulty in trying to increase root yield and sucrose content simultaneously.

Table 4. Sucrose yield, root yield, and % sucrose of selections for high seedling dry weight, hypocotyl diameter and % dry weight, and the parent population.

Selection parameter	Gross sucrose Lbs/A	Selection parameter	Root yield T/A	Selection parameter	Sucrose %
High DW	7935	High HD	31.1	High % DW	12.8
Parent (h495)	8152	Parent (h495)	28.5	Parent (h475)	14.3
LSD 0.05	886		2.5		0.7

Both high and low selections were made in population h8 (Table 5). There were significant differences between the high and low selections for gross sucrose, root weight, and percent sucrose. The high selections were higher than the parent and the low selections were lower than the parent, except for percent sucrose where both high and low percent dry weight selections gave higher sucrose concentration than the parent. Even though the high selections were higher than the parent, this increase did not reach significance for gross sucrose or root yield. The trends were, however, in the right directions and suggests that under highly controlled conditions genetic progress should be achievable.

Table 5. Sucrose yield, root yield, and % sucrose of high and low selections for seedling dry weight (DW), hypocotyl diameter (HD), % dry weight (% DW), and of the parent population (h8).

Selection parameter	Gross sucrose Lbs/A	Selection parameter	Root yield T/A	Selection parameter	Sucrose %
High DW	8440	High HD	31.3	High % DW	14.0
Low DW	7698	Low HD	26.7	Low % DW	13.8
Parent (h8)	7774	Parent (h8)	29.7	Percent (h8)	13.1
LSD 0.05	858		2.5		9.7

It is difficult to find selections high in all three seedling parameters. Selections for all three seedling parameters (dry weight, hypocotyl diameter and percent dry matter) and sufficient seed to field test were obtained in two populations (g237 and m39). The selection from g239 was equal to the mean of the parent in dry weight and root yield but higher than the parent in percent dry weight, whereas the selection from m39 was higher than the parent for all three parameters (Table 6).

Table 6. Sucrose yield, root yield, and % sucrose of selections for dry weight (DW), hypocotyl diameter (HD), % dry weight (% DW), and of the parent populations g237 and m39.

Selection parameter	Gross sucrose Lbs/A	Root yield T/A	Sucrose %
$\bar{x}$ DW and HD, high % DW	10,149	35.5	14.2
Parent (g237)	10,499	35.7	14.7
LSD 0.05	906	2.6	0.7
High DW, High HD, high % DW	10,010	34.7	14.4
Parent (m39)	9,354	33.3	14.1
LSD 0.05	974	3.0	0.6

The selection from g237 should have had a higher percent sucrose than the parent; however, it was lower in percent sucrose than the parent. The other data (gross sucrose and root yield) were the same as the parent. The selection from m39 was higher than the parent in sucrose yield, root yield, and percent sucrose as was expected; however, the increases were not significant.

These results point out the difficulty of increasing both root yield and percent sucrose simultaneously. In most cases, selection for large hypocotyl diameter increases root yield. However, because of the negative correlation between root yield and sucrose content, much of the selection pressure for root yield is negated if selection pressure is also exerted for sucrose content.

Selection for percent dry weight did not show positive selection pressure for percent sucrose. The results were both positive and negative suggesting random selection. In more comprehensive studies, it was found that percent dry weight in the seedling stage did not reflect genetic differences in percent sucrose. Genotypes differing in potential percent sucrose were very similar in seedling percent dry weight. This is due largely to osmotic equalibrium; i.e., low sucrose genotypes were high in non-sugar osmolites and visa versa. This results in similar osmotic pressure, specific gravities and percent dry weight of genetically different sucrose genotypes.

These studies further suggested that fiber content in the seedling stage would give an indirect measure of relative cell size and result in better identification of sucrose potential. Sufficient seed was obtained from one selection for high seedling percent fiber to test in a replicated field trial. The results were disappointing in that the sucrose content of the high seedling percent fiber selection was not different from the parent.

We are, therefore, investigating other selection criteria for identification of superior sucrose genotypes in the seedling stage of growth.

C. Selection for Potential Sucrose Content in 6-Day-Old Plants

We have previously shown that genetic differences in cell size are manifest in the initial cortex cells laid down by the germinating root. In addition, the number of rows of cortex cells laid down do not vary by genotype; i.e., all genotypes lay down the same number of rows. These two facts suggest that a simple measurement of the root diameter of newly germinated seeds should render a relative measurement for cortex cell size. This measurement should, therefore, correlate with sucrose content. A series of tests using genotypes of known sucrose potential gave correlations of approximately -0.60 between sucrose content and root diameter of 6-day-old plants.

These results led to selection studies. In this report, we will examine the field data of two of these selection studies evaluated in replicated trials this past year.

Study One

A number of lines were screened for root diameter of 6-day-old seedlings. Several lines were selected for large and several for small root diameter at 6 days. Seed increases were made of these lines for testing in replicated field trials in 1982. The small diameter lines should exhibit a higher sucrose content than the large diameter lines. This result was not achieved. One of the large diameter lines (1244) had the highest percent sucrose (Table 7). The remainder of the lines fell into the expected result; however, none of the differences were significant.

Table 7. Root diameter of 6-day-old plants and their sucrose content obtained from replicated field trials.

Line	Root diameter inches X 10^{-3}	Sucrose %
1231	27.80	14.6
1222	27.37	14.5
1236	27.12	14.6
1226	28.84	14.3
1244	28.78	15.0
LSD 0.05	0.76	0.5

Study Two

In this study, individual plants were selected based on their root diameter at 6 days. Plants were selected from two heterozygous populations. All plants with root diameters smaller than one standard deviation below the parent mean were placed in an isolation chamber to produce the small root

diameter selection of each parent. All plants with root diameters larger than one standard deviation above the parent mean were placed in another isolation chamber to produce the large root diameter selection of each parent. These selections along with the parent populations were tested in replicated field trials (Table 8).

Table 8. Sucrose content of selections made for small and large root diameters at 6 days of age and of the parent population.

Selection paremeter	Sucrose %
Small root diameter at 6 days	13.0
Large root diameter at 6 days	12.9
Parent (h537)	12.9
Small root diameter at 6 days	15.1
Large root diameter at 6 days	14.7
Parent (f354)	14.6
LSD 0.05	0.5

In both populations, the small root diameter selection had a higher sucrose content than the large root diameter selection and the parent population. However, only in the f354 population did the small root diameter selection significantly exceed the parent in percent sucrose. In both populations, the large root diameter selection gave the same sucrose content as the parent.

In general, selection for small root diameter of 6-day-old seedlings tended to increase sucrose content. Differences were, however, small and only showed significance in one case.

D. Stress Selection

When selecting for yield, plant breeders generally attempt to create ideal conditions to allow for full genotypic expression. One of the difficulties often encountered is the high environmental variation that accompanies yield evaluations. This variation is offtimes so large it masks true genetic differences. The ability of the plant breeder to identify superior genotypes can be improved, either by decreasing the environmental variation or by increasing the genetic variation. It has been suggested that the genetic variation might be increased by the introduction of appropriate stress factors. In theory, appropriate stress should enlarge the differences between weak and vigorous genotypes. Two elements are essential for stress to have a significant effect on genetic variation: 1) the stress factor must be highly heritable, and 2) the stress factor must be correlated with the desirable selection trait (vigor, yield, etc.)

We have investigated two stress factors related to yield: 1) competition, and 2) recovery.

1. Competition - The use of competitive stress to select for yield. Competition is measure as: competitive ability (CA) = ability of a given genotype to compete against its neighbor, i.e., its yield relative to other genotypes under the same competition, and competitive influence (CI) = the effect a given genotype exerts on its nearest neighbor.

These competitive effects were measured in small pots. One seed from a heterozygous population was planted in the center of 400 pots. Four seeds of a uniform hybrid (common competitor) were then planted in the four corners of each pot. At four weeks of age, all plants were weighted and the competitive ability and competitive influence of each plant determined. Plants were selected for both CA and CI. The most desirable plant would have a high CA and a low CI; i.e., high individual yield and high common competitor yield. It was very difficult to find this combination of effects. Most plants that were high in root yield decreased the common competitor root yield. Therefore, selections were for high CA and mean CI; i.e., plants that gave high root yields but did not decrease the common competitor root yield. All selected plants were placed in an open-pollinated polycross to produce the new selection population. Two selection populations were produced in each of two heterozygous populations. These selections and their parent populations were tested in replicated field trials in 1982. They were tested in different field trials but are combined in the same table for convenience (Table 9).

The selections from population h537 did not differ in root yield from the parent; however, one selection had a higher percent sucrose and total sucrose yield than the parent. On the other hand, the selections from population g237 were not different in percent sucrose from the parent, but were higher in root yield and sucrose yield. These differences, however, were not significant.

Table 9. Sucrose yield, root yield, and % sucrose of selections for high competitive ability (CA) and mean competitive influence (CI) and of the parent populations.

Selection parameters	Sucrose yield Lbs/A	Root yield T/A	Sucrose %
m141 (high CA, $\bar{x}$ CI)	8949	31.2	14.3
m150 (high CA, $\bar{x}$ CI)	7761	29.4	13.1
Parent (h537)	7807	30.1	12.9
LSD 0.05	1144	4.8	0.9
m142 (high CA, $\bar{x}$ CI)	10699	37.3	14.4
1287 (high CA, $\bar{x}$ CI)	10993	36.9	14.9
Parent (g237)	10499	35.7	14.7
LSD 0.05	906	2.6	0.7

Differences were in the right direction, but not large enough to make any definite conclusions about the merits of this selection procedure. Results were reported last year in which selection for competitive ability increased root yield but decreased percent sucrose. The inability to make significant gains is probably due to the fact that one of the essential elements (high heritability) was lacking. Controlling growth so that uniform measurements of competition could be measured was difficult. In our selection procedure, genetic variation was probably increased but environmental variation for the competitive effects was also increased, making it difficult to select true genetic differences in competition.

2. Recovery Stress - A method was developed to measure the ability of a given genotype to grow and store photosynthate rapidly in the seedling stage. Those genotypes that grow most rapidly in the seedling stage are generally the superior sucrose producers.

   Plants were grown in small pots. At a very young age all leaves were trimmed and the plants covered with dark plastic. This forced the plants to produce more leaves by immobilizing their stored photosynthate. Plants with very little stored photosynthate died. Three tests were conducted to evaluate recovery rates on a series of genotypes of known vigor (Table 10).

Table 10. Percent plants surviving stress imposed by trimming leaves of three- and four-week-old plants and covering with black plastic for 10 days. Twelve genotypes ranging in plant vigor were evaluated.

	% plants surviving 10 days Of dark following leaf removal		
	Four-week-old-plants	Three-week-old-plants	
Genotype	Run 15	Run 17	Run 18
GW149	100	35	40
AH14	89	32	20
Hilleshog 309	96	21	7
Beta 9421	91	42	46
USH11	79	53	20
Monorosa	80	16	30
Monovigor	90	7	26
US22/3	71	13	13
Camobarres	48	3	6
C17	64	9	4
L10	85	0	0
L19	63	0	0

In general, the most vigorous genotypes had the best survival rate. It is interesting to note that the large root-low sucrose fodder beet (Camobarres) and the small root-high sucrose sugarbeet (L19) both had poor survival rates. These results suggest that about a 30 percent survival rate can be obtained by applying the stress treatment at

about three weeks of age.

Questions that arose are, "Do the more vigorous genotypes recover more rapidly and increase their differences after the stress treatment," and, "Does the relative sucrose content of the roots change due to the stress and recovering treatment?" Two tests were conducted to answer these questions.

Six hybrids differing in potential root yield were grown to the four week stage before the stress treatment was applied. Half of the plants were harvested for root weight measurements at four weeks of age. The remaining plants were covered with black plastic for 10 days after removal of the leaves. Surviving plants were grown for another three weeks, harvested, and roots weighed. This test was repeated twice.

All genotypes recovered and grew at about the same relative rate after stress treatment as before (Table 11). There was no stress times genotype interaction. The correlations between root weight before stress treatment and after recovery were 0.96** and 0.89** for the two evaluations, respectively.

Table 11. Root weight of six genotypes at four weeks of age and after stress treatment (removal of leaves followed by 10 days of dark) and a three-week recovery period.

	Fresh Root Weight			
	Four weeks of age		Three-week recovery following stress	
	Evaluation 1	Evaluation 2	Evaluation 1	Evaluation 2
Genotypes	mg/root	mg/root	mg/root	mg/root
GW149	1159	1273	1986	2071
Hilleshog 309	1131	1115	1919	2057
USH11	1002	953	1881	1899
Beta 9421	864	928	1690	1881
AH14	904	930	1603	1741
US22/3	739	781	1455	1497
LSD 0.05	161	194	287	378

Another test was conducted very similar to the one above except the percent sucrose was measured before stress and after recovery. This test consisted of 10 genotypes representating a wide range of sucrose potential (Table 12).

The relative sucrose content did not change due to the stress treatment. A ranked correlation of 0.90** was obtained for sucrose content between the four-week age and recovery plants.

Table 12. Percent sucrose of 10 genotypes at 4 weeks of age and after stress treatment (removal of leaves followed by 10 days of dark) and a three-week recovery period.

Genotype	Four weeks of age % sucrose	Three weeks recovery following stress % sucrose
GW149	8.50	10.88
AH14	5.88	10.58
Hilleshog 309	5.78	10.86
Beta 9421	6.21	10.20
USH11	5.81	10.14
US22/3	5.73	10.42
g241	5.12	9.18
Monovigor	5.26	8.74
Monorosa	4.64	8.76
Camobarres	1.62	7.66
LSD 0.05	0.78	1.36

These data suggest that recovery rates and sucrose accumulation rates are not altered by the stress treatment. There was, however, sufficient correlation between survival rate and vigor to warrant further testing. Two heterozygous populations were grown to the three-week stage and stress applied. Plants that survived (29 and 19 percent, respectively) were saved and photothermally induced for seed production. These will be tested in replicated field trials in 1983 and 1984.

IV. GROWTH ANALYSIS

ROOT/TOP PARTITIONING AMONG INBREDS AND THEIR DIALLEL CROSS HYBRIDS

J. C. Theurer

Partitioning of photosynthate to the economic harvested part of the plant is one potential means of increasing crop yields. In the case of sugarbeets, this would be the partitioning of more photosynthate to the root, and subsequently into sucrose. It could also involve an optimum time element for this partitioning to occur. In 1981, we initiated an experiment to evaluate the seasonal partitioning of photosynthate in inbreds that differed greatly in their root/top partitioning ratio, sucrose content, and root yield. In addition, we evaluated the diallel crosses between these inbreds in an effort to observe the hybrid response based on inbred partitioning. Results of this study were reported in the 1981 Sugarbeet Research Report, p. B29-B33. In 1982, we repeated this study to obtain another year's data and included a larger number of replications in the test. The four genotypes selected for the study are listed below:

Code	Description
HPR	Inbred selected for high partitioning ratio to the root.
HS	Inbred high in sucrose content and high in general combining ability for sucrose.
HY1	Inbred high in yield and in general combining ability for yield.
HY2	Inbred with low yield but good general combining ability for high yield.

In 1981, there was insufficient seed available for the cross HY1 X HS to be included in the test. However, seed of all six possible crosses between the four inbreds was available for the 1982 field test.

The inbreds and diallel crosses were planted in six replications of a randomized block design. Inbreds were grouped in one part of each replicate and hybrids in the other with one row of an inbred and one row of a hybrid as buffers between the two sections. Reps were also buffered by an inbred or hybrid on the periphery of each replicate. Individual plots consisted of two rows, 56 cm (22 inches) apart and 11 m (37 feet) long. At harvest, all plants of each plot were dug by hand and soil was removed from the roots. Tops were removed by trimming all of the green from the crown of each root. Tops and roots were immediately weighed following their separation. Two representative tops were selected, weighed, and dried in an oven at 100 C to determine dry matter percentage of tops. Ten roots from each row were selected for determining sugar content. Roots were washed and sampled with a spreckles saw to obtain brei for laboratory analysis. Sucrose percentage was determined by the cold diges-

tion method. A sample of pulp was collected in an aluminum weighing dish and dried in an oven at 100 C to obtain a dry matter percentage of the root for each variety. Three harvests were made during the year, July 14 (approximately 60 days after planting), August 28, and October 6. Root/top ratios were calculated on both a fresh weight and a dry weight basis.

Results

The results of partitioning on both a fresh weight and a dry weight basis were similar to those observed in 1981 (Tables 1 and 2). There was an increase in partitioning ratio for every entry as the season progressed. The HY2 inbred had the second highest root/top partitioning ratio at the first harvest and the highest ratio at Harvest 3.

Table 1. Root/top fresh weight ratios for four diverse inbreds and their diallel hybrids during the growing season, Logan, Utah, 1982.

	Harvests		
Entry	H1	H2	H3
HRP	0.34	1.1	1.8
HS	0.21	0.6	1.1
HY1	0.17	0.6	1.0
HY2	0.27	1.0	2.2
HY1 X HRP	0.27	0.8	1.4
HY2 X HRP	0.32	1.0	1.7
HS X HRP	0.28	0.8	1.4
HY1 X HS	0.23	0.7	1.4
HY2 X HS	0.25	0.7	1.4
HY1 X HY2	0.24	0.7	1.5
Mean	0.26	0.8	1.5
LSD 0.05	0.02	0.05	0.23

Significant differences were noted for partitioning between the inbreds; however, HS and HY1 partitioned similarly for each harvest throughout the season. It was particularly interesting and a non-expected result to have the high sugar and high yield lines partition in a non-significant manner. The hybrid of HRP X HY2 was significantly the highest in partitioning ratio among the diallel crosses. At the first and second harvest, significant differences were noted between other hybrids. However, at the final harvest, all of the other crosses in the diallel had similar partitioning.

Table 2. Root/top dry matter ratios for four diverse inbreds and their diallel hybrids during the growing season, Logan, Utah, 1982.

Entry	Harvests H1	H2	H3
HRP	0.35	1.58	2.04
HS	0.20	0.98	1.44
HY1	0.19	0.89	1.32
HY2	0.28	1.52	2.28
HY1 X HRP	0.32 b	1.26 bc	1.80 b
HY2 X HRP	0.38 a	1.56 a	2.15 a
HS X HRP	0.32 b	1.32 b	1.88 ab
HY1 X HS	0.26 c	1.09 d	1.80 b
HY2 X HS	0.31 b	1.21 bcd	1.79 b
HY1 X HY2	0.28 bc	1.11 cd	1.90 b
Mean	0.29	1.25	1.84
LSD 0.05	0.04	0.16	0.27

The fresh root weight of inbreds and hybrids is given in Table 3. HY1 and HS had significant differences in root weight for each harvest. The HY1 X HY2 hybrid produced significantly the greatest weight of roots at final harvest. Based on partitioning at Harvest on a dry weight basis (Table 2), there was apparently no relationship with partitioning and root yield. HY1 X HY2 had the highest root weight but this cross ranked fourth highest in partitioning ratio. Partitioning at Harvest 4 showed a closer relationship to root yield than partitioning at Harvest 1 in that the HY2 crosses were among those with the highest root yield. However, the correlation with partitioning and root weight at this harvest also was not good.

Sucrose percentage was, as expected, highest for the HS inbred and the hybrids with HS as a parent. Based on the mid-parent values of the inbreds, there was a perfect rank correlation with the sucrose percentage of the crosses. HS X HY2 had the highest sucrose content and HPR X HY1 the lowest. There was no close association of partitioning and sucrose content with either early or final harvests. For example, HY2 X HS was second lowest at Harvest 3 (Table 4). At Harvest 4, HS X HY2, which ranked third based on partitioning, and HRP X HS, which ranked fifth based on partitioning, were highest in sucrose percentage.

HY1 X HS had the highest total sugar yield of the hybrids, but there was no significant difference between any of the hybrids. With such close values of sugar yield for each hybrid, it was not possible to get a good indication of the association of partitioning and sugar yield.

Table 3. Fresh root weight for four diverse inbreds and their diallel hybrids for three harvests during the 1982 growing season at Logan, Utah.

Entry	Harvests H1	H2	H3
	t/ha		
HRP	1.03	18.76	39.70
HS	1.84	26.35	50.80
HY1	1.90	31.15	60.69
HY2	0.92	15.54	31.33
HY1 X HRP	2.89	37.87	64.94
HY2 X HRP	3.31	34.93	58.98
HS X HRP	3.32	36.06	60.75
HY1 X HS	3.59	35.06	64.94
HY2 X HS	3.64	34.54	60.18
HY1 X HY2	3.28	35.31	70.01
Mean	2.57	30.56	56.23
LSD 0.05	0.28	4.13	4.95

Table 4. Sucrose percentage for four diverse inbreds and their diallel hybrids for three harvests during the 1982 growing season at Logan, Utah.

Entry	Harvests H1	H2	H3
HRP	8.11	14.10	15.91
HS	7.78	15.40	18.61
HY1	7.61	12.97	15.05
HY2	7.95	14.50	16.10
HY1 X HRP	8.39	14.27	15.42
HY2 X HRP	8.27	14.60	16.61
HS X HRP	9.42	15.92	17.60
HY1 X HS	8.38	14.88	16.86
HY2 X HS	9.35	15.62	17.94
HY1 X HY2	8.92	14.62	15.49
Mean	8.42	14.69	16.56
LSD 0.05	0.57	0.66	0.75

Table 6 shows heterosis for partitioning of root dry matter at each harvest. During the first harvest, all hybrids showed heterosis over the mid-parent mean. This could possibly be attributed to the greater vigor and more rapid

cell division of the hybrid at this growth stage. Only the cross of HY1 X HS, the hybrid that had the highest sugar yield, showed heterosis at the second and third harvest dates.

It would appear that partitioning is another independent factor which along with heterosis for yield and high sugar content could improve sugar production. It is evident we need more research on the genetic, physiological, and biochemical factors that govern partitioning of assimilate in the sugarbeet plant.

Table 5. Total sugar yield mg ha^{-1} of four diverse inbreds and their diallel crosses at Logan, Utah, 1982.

	Harvests		
Entry	H1	H2	H3
HRP	0.08	2.65	6.31
HS	0.14	4.05	9.47
HY1	0.14	4.06	9.12
HY2	0.07	2.25	5.07
HY1 X HRP	0.24	5.39	10.01
HY2 X HRP	0.27	5.10	9.79
HS X HRP	0.31	5.69	10.73
HY1 X HS	0.30	5.22	10.93
HY2 X HS	0.34	5.40	10.79
HY1 X HY2	0.29	5.16	10.84
Mean	0.22	4.50	9.31
LSD 0.05	0.03	0.65	1.65

Table 6. Heterosis for root/top dry weight ratios of inbreds and diallel crosses, 1982.

	H1		H2		H3	
Entry	MP	Het	MP	Het	MP	Het
HY1 X HRP	.275	.045*	1.25	0.05	1.65	0.15
HY2 X HRP	.315	.065*	1.55	0.05	2.16	-0.05
HS X HRP	.275	.045*	1.30	0.00	1.70	0.20
HY1 X HS	.200	.060*	0.95	0.15*	1.35	0.45**
HY2 X HS	.240	.070*	1.25	-0.05	1.85	-0.05
HY1 X HY2	.240	.040*	1.21	-0.10	1.80	0.10
LSD 0.05		.025		0.14		.236
0.01		.087		0.19		.314

V. INSECT STUDIES

SELECTION FOR PLANT RESISTANCE TO THE SUGARBEET ROOT MAGGOT

J. C. Theurer, C. C. Blickenstaff, and G. G. Mahrt

In 1982, a continuing cooperative research program to develop resistance to the sugarbeet root maggot *tetanops myopaeformis* (Roder) was carried out between C. C. Blickenstaff and G. G. Mahrt, Entomologist and Agricultural Research Technician, Kimberly, Idaho; J. C. Theurer, Geneticist, USDA/ARS, Logan, Utah; D. L. Oldemeyer, Research Director, The Amalgamated Sugar Company (TASCO), Nyssa, Oregon, and A. W. Anderson, Entomologist, North Dakota State University, Fargo, N. Dak. Experiments were conducted at Kimberly and Paul, Idaho, and St. Thomas, N. Dak. Dr. Theurer and Dr. Oldemeyer developed the seed of inbred selections, hybrids, and other progenies used in all tests. Dr. Blickenstaff organized the field trials and oversaw the planting and data collection at all locations. Dr. Mahrt was responsible for the field trials in Idaho and Dr. Anderson for the field trials in North Dakota.

Field tests included: 1) evaluation and reselection in the fourth and seventh cycles of recurrent phenotypic selection originally from the two USDA broad-based populations, 2) evaluation and selection of inbreds and sibbed progeny for maggot resistance, 3) evaluation and reselection from crosses between USDA and TASCO low-damage lines, 4) evaluation of crosses and selections to determine the breeding behavior and inheritance of maggot resistance, and 5) comparison tests in Idaho and North Dakota for combining ability yield and relative root maggot damage.

Phenotypic Recurrent Selection

Cycle 7 selections for low sugarbeet root maggot damage, originally made in 1976 and further selected in 1977 through 1981 out of a broadbase population, 25A2, were evaluated in field trials at Kimberly, Idaho, in 1982. The original parent and a high-damage inbred check, L19, were also planted for comparison. Plants were dug mid-July and each root was rated for maggot feeding damage on a scale of 0 = no damage, to 5 = dead or dying beet. Highly significant differences were found between entries for damage ratings (Table 1). The low-damage selection had the lowest damage ($\bar{x}$ rating of 1.9), while the original parent showed the most injury ($\bar{x}$ rating of 3.0). Progress can be measured by comparing the damage ratings for the low-damage selection as a percentage of the damage of the parent. From 1976 to 1981, we made steady progress reducing the damage on the average of 6 percent per year. Little progress was made this year in selection cycle 7. It may be that we have reached a plateau in the degree of resistance we can obtain in this population by phenotypic recurrent selection (Table 2). The 5 percent least damaged roots were reselected for further seed production and testing.

Table 1. Performance of selections from the 25A2 population (C_7 cycle), ARS, Section II.

	1981 ARS designation	$\bar{x}$ SBRM damage rating	$\bar{x}$ stand per row	Total no. plants	% perfect stand
40K98 (low damage)	40J20	1.9 a[1/]	8.5 b	213	85
25A2 (parent)	25A2	3.0 c	7.4 a	184	74
919 (L19 check)	L19	2.7 b	7.1 a	178	71
F		28.58**	6.52**		

1/ Means not followed by the same letter are significantly different $P < .05$ as compared by a Duncan's multiple range test.

**Significant $P < .01$.

Table 2. Progress in selection for high damage through 1981 and low damage through 1982, ARS, Section II.

	Ratings as a percent of the parent.						
	1976	1977	1978	1979	1980	1981	1982
High damage selections	116	103	121	115	133	79	-
Low damage selections	96	86	89	81	76	64	63

Table 3. Performance of selections from the 35G3 population (C_4 cycle), ARS, Section I.

	1981 ARS designation	$\bar{x}$ SBRM damage rating	$\bar{x}$ stand per row	Total no. plants	% perfect stand
40K15 (low damage)	40J19	2.0 a[1/]	8.2 ab	204	82
35G3 (parent)	35G3	2.4 b	9.0 b	226	90
40K0 (high damage)	40J38	2.8 c	8.4 ab	209	84
919 (L19 check)	L19	2.6 bc	7.6 a	190	76
F value		12.23**	3.45*		

1/ Means not followed by the same letter are significantly different $P < .05$ as compared by a Duncan's multiple range test.

** = significant at $P < .01$, * = significant at $P < .05$.

Selection in a second non-related heterogeneous population was begun in 1979, and the fourth cycle of recurrent selection was evaluated at Kimberly in 1982. Selection was made for both high and low damage each year. Highly significant differences were found among entries (Table 3). The low-damage selection had the least injury ($\bar{x}$ damage rating of 2.0) while the high-damage selection had the greatest injury ($\bar{x}$ rating of 2.8). Progress was again measured in percentage of the damage of the parent population for each cycle (Table 4). It appeared that the damage rating had been reduced by 23 percent compared to the parent in 1981. However, the 1982 ratings suggested that no progress was made in increasing resistance in this population. In the 25A2 population, a similar result occurred in Cycle 3 in 1978, and yet in subsequent cycles of selection root maggot damage was reduced. One or two additional cycles of selection are needed to positively prove whether or not this population carries resistant genetic factors that merit additional selection, since the degree of infestation and environmental factors can effect the results of any single year. The best 5 percent of low-damage plants were kept for seed increase and subsequent evaluation and reselection.

Selection for Resistance in Inbreds and Sibbed Progenies

Inbred progenies selected from individual low-damage plants from population 25A2 in different cycles of the recurrent selection program were evaluated in replicated field plots at Kimberly, Idaho this year. Some of these progenies were selected as early as 1976 and reselected in subsequent years. These showed inbreeding depression for vigor. The inbred L19 and a high-damage selection were planted as checks. Significant differences among entries were observed for both damage rating and plant stand (Table 5). The correlation between damage rating and plant stand was also significant ($r = -0.259$, $P < .05$). Ratings ranged from a low of 2.2 for a low-damage selection, to a high of 4.1 for the high-damage entry. Some entries in past years have been rated as low as 0.5 or 0.8. However, they do not retain this low of a rating from year to year. Ratings of 1.5 to 2.0 is the area where the best inbreds seem to stabilize. Further selection in this material will not be made, but the better resistant lines will be released to the sugarbeet industry.

Table 4. Progress in selecting for high and low damage through 1982, ARS, Section I.

	Rating as a percent of the parent			
	1979	1980	1981	1982
High damage selections	114.7	130	90	116
Low damage selections	82.4	90	77	83

Table 5. Performance of inbreds and sib progeny selections in 1982, ARS, Section IV.

Line No.	$\bar{x}$ SBRM damage rating	No. of replications	$\bar{x}$ stand per row	Total no. plants	% perfect stand
40K15-4	3.2 bc[1/]	10	8.4 c	84	84
40K16-3	2.7 abc	3	5.3 a	16	53
40K49-3	2.9 abc	10	8.2 c	82	82
40K1101	2.8 abc	13	6.1 ab	79	60
40K30-2	3.1 bc	3	5.0 a	15	50
40K52	2.5 ab	10	7.9 c	79	79
4016-1	2.2 a	4	8.0 c	32	80
40K16-2	2.5 ab	1	9.0 c	9	90
40K7	4.1 d	3	5.7 ab	17	57
HD Check	3.3 c	10	8.2 c	82	82
L19 Check	3.3 c	13	7.1 bc	92	71
F Value	2.97**		4.14**		

1/ Means not followed by the same letter are significantly different $P < .05$ as compared by a Duncan's multiple range test. ** = significant at $P < .01$.

Crosses Between USDA and TASCO Low-damage Selections

In 1979, the USDA provided five low-damage lines to TASCO and TASCO provided the USDA with four low-damage lines of their most resistant plant material. Crosses were made by both TASCO breeders and by Dr. Theurer (USDA at Logan) to combine genetic factors for resistance from the two sources. In 1982, 21 of the best second segregating generation (F3) low-damage selections from crosses made at Logan were planted at Kimberly. The inbred check L19 was also planted for comparison. There were no significant differences for damage rating among the progenies from the original crosses, although there was a 32 percent difference between the least damaged entry ($\bar{x}$ rating of 1.7) and the most damaged entry ($\bar{x}$ rating of 2.5) (Table 6). There were significant differences among entries for plant stand and damage was inversely correlated with stand. ($r = .21$, $P < .05$).

Breeding Behavior and Genetics of Root Maggot Resistance

In 1981, parents F_1 and F_2 progenies of two resistant X susceptible crosses were evaluated at Kimberly. Data failed to show meaningful segregation patterns. All roots of the F_2 generation from each of the two crosses were classified and separated into 0 to 5 damage categories. Roots were photothermally induced and seed was produced on each root at Logan. F_3 progenies of the two F_2 familes were evaluated in a replicated field test at Kimberly in 1982. Differences among entries were highly significant for damage ratings. However, damage ratings were not in consistent agreement with ratings given to the individual F_2 plants in 1981. Segregation patterns again were not meaningful. There were no significant differences in stand in this test. While selection progress in the 25A2 population suggests additive genetic factors are important in maggot resistance, observations on segregating progenies in 1981 and 1982

field tests would also indicate a complex pattern of inheritance. The amount of environmental variation prevalent in field tests suggests that critical inheritance studies of root maggot resistance will need to be made in the greenhouse where the degree of infestation and environmental factors can be better controlled.

Table 6. Performance of selections from TASCO-USDA crosses (F_3), ARS, Section III, 1982.

Line No.	$\bar{x}$ SBRM damage rating	No. of replications	$\bar{x}$ stand per row	Total no. plants	% perfect stand
40K99	1.7	11	8.6 cd[1/]	95	86.4
40K17	2.2	4	7.8 abc	31	77.5
40K100	-	2	0	0	-
40K18	2.3	2	10.0 d	20	100
40K55	1.7	11	8.8 cd	97	88.2
40K19	2.5	2	6.5 a	13	65.0
40K20	2.2	4	8.5 bcd	34	85.0
40K101	1.9	6	9.2 cd	55	91.7
40K21-2	1.7	4	8.8 cd	35	87.5
40K57	1.7	10	8.5 bcd	85	85.0
40K23-2	1.8	3	7.7 abc	23	76.6
40K25-3	2.1	6	6.7 ab	40	66.6
40K102	1.9	5	9.8 d	49	98.0
40K26	1.8	1	9.0 cd	9	90.0
40K27	2.1	10	8.5 bcd	85	85.0
40K29	1.7	10	8.2 abcd	82	82.0
40K5	1.8	11	7.5 abc	82	74.5
40K32	1.7	4	8.8 cd	35	87.5
40K3-7	1.7	8	8.4 bcd	67	83.8
40K33-4	1.9	4	6.5 a	26	65.0
40K31-2	2.0	3	8.7 cd	26	86.7
L19 Check	2.2	19	6.7 ab	128	67.4
F Value	1.12ns		5.54**		

[1/] Means not followed by the same letter are significantly different P < .05 as compared by a Duncan's multiple range test. ** = significant at P < .01, ns = nonsignificant.

Comparison of Maggot Resistant Plant Material in Idaho and North Dakota

In 1982, experiments were initiated to compare maggot resistant selections in Idaho and North Dakota. In one experiment, three F_3 selections from USDA-TASCO resistant crosses, and six inbred and sibbed lines selected for resistance were evaluated at Kimberly, Idaho and St. Thomas, N. Dak. A high-damage entry was included in the test as a check. There were no significant differences among entries for damage at either location or when the locations were combined.

However, there was considerable difference between locations for the mean overall damage. Beets grown at Kimberly averaged almost twice as much damage ($\bar{x}$ rating 2.9) compared to St. Thomas ($\bar{x}$ rating 1.5). Although not entirely consistent, the relative ratings were similar for the two locations suggesting that maggot resistant lines selected in Idaho would also be resistant in the Red River Valley. There were highly significant differences in stand for the entries at each location. The same entries were either good and poor in stand at the two locations, indicating stand problems were related to seed germination.

Table 7. Comparison of inbred selections grown at Kimberly, Idaho, and St. Thomas, N. Dak., 1982.

	Damage rating			Stand at harvest		
Entry	ID	ND	$\bar{x}$	ID	ND	$\bar{x}$
			F_3 selections of TASCO X USDA			
1-40K55	1.7	1.6	1.6	8.7	5.2 a	7.0 a
2-40K57	1.7	1.4	1.5	8.1	8.2 b	8.2 b
3-40K27	2.1	1.4	1.8	8.4	9.2 b	8.8 b
F	2.43 ns[1/]	0.32 ns	0.84 ns	0.77 ns	10.98**	5.26*
C. V.	30.51	36.17	30.22	13.77	25.45	15.24
			Logan inbred and sib lines			
4-40K15-4	3.2	1.6	2.4	7.6 b	7.2 bc	7.4 c
5-40K16-3	2.7	1.5	2.2	5.0 a	7.6 cd	6.3 b
6-40K49-3	2.9	1.9	2.4	7.6 b	9.8 e	8.6 d
7-40K11-1	2.8	1.1	1.9	5.5 a	6.1 ab	6.3 b
8-40K30-2	3.1	1.3	2.3	4.3 a	4.8 a	4.5 a
9-40K52	2.5	1.6	2.1	7.3 b	8.3 cd	7.9 cd
10-40K60 (HD)	3.3	1.5	2.4	7.5 b	8.8 de	8.3 cd
F	2.23 ns	1.71 ns	2.09 ns	4.05**	10.23**	14.73**
C. V.	29.76	32.60	13.21	27.46	18.63	10.96

[1/] Means not followed by the same letter are significantly different P < .05 as determined by a Duncan's multiple range test. ** = significant P < .01, * = significant P < .05, ns = nonsignificant. C. V. = coefficient of variation.

In a second comparative experiment, 10 entries consisting of open-pollinated maggot selections and hybrids with maggot resistant parents were planted in replicated field plots in an area north of Paul, Idaho, known to be a location with heavy maggot infestation, and in St. Thomas, N. Dak. One-half of the plots in the Idaho test were treated with the systemic insecticide Aldicarb at two pounds active ingredient per acre. In addition to damage ratings, root yield, sugar percentage, and percent tare were taken at harvest in late September (St. Thomas) or early October (Paul).

Maggot feeding damage was comparatively light and there were no significant differences among entries for damage ratings in either Idaho or North Dakota (Table 8). Overall damage was about 21 percent higher in Idaho (untreated plot $\bar{x}$ rating = 1.9) compared to the North Dakota rating (1.5). In all cases, damage was reduced with the use of Aldicarb in the Idaho tests and six of eight comparisons showed significance.

Differences among the entries for root yield were highly significant at both the Idaho and North Dakota locations. However, damage ratings were not significantly correlated with yield. With some minor variations, the entries showed similar response at each location. The Aldicarb treated plots averaged one ton per acre over the mean root yield of the untreated plots.

There were highly significant differences between entries for sugar percentage at both locations and the relative response of entries was similar at each location. There were also significant differences for tare percentage at St. Thomas.

There was a serious problem which undoubtedly affected both damage ratings and stand at St. Thomas. On July 4, the area received 6+ inches of rain and hail. The area was inundated and plants were under standing water for several days. Beets were dying and beginning to decay. Damage ratings were, therefore, taken two to three weeks earlier than the normal time for evaluation. These conditions probably adversely affected the root yield and sugar content as well. In addition, root maggot feeding damage appeared to be light at both locations and the entries were not as well separated in ratings as had been observed under heavier infestations in past years. Even so, since many of the trends for root damage, root yield, and sucrose content were the same at both locations, it would suggest that there are not different biotypes of the root maggot at the different locations. Thus, lines with good resistance at one location should also be resistant at the other. Additional testing should be carried out in 1983 and subsequent years, hopefully, with higher sugarbeet root maggot infestations and better environmental conditions to confirm this premise. Seed of hybrids with some of the best maggot resistance were produced this summer in garden isolations, and seed of inbreds and sibbed lines will be produced during the winter of 1982-83 for these experiments.

Table 8. Comparison of open-pollinated progenies and hybrid crosses at Paul, Idaho and St. Thomas, N. Dak., 1982.

	Damage			Yield (T/A)[1/]			% sugar		
	ID		ND	ID		ND	ID		ND
Entry	T[2/]	U	U	T	U	U	T	U	U
1-E1136	1.5	2.0	1.4	18.7c[3/]	18.3c	16.5cd	14.04b	14.05bc	13.3ef
2-E1137	1.6	1.9	1.8	18.9c	18.1c	17.0cd	13.32ab	13.39abc	12.5bc
3-E1138	1.4	2.0	1.6	19.6c	18.8c	17.8d	13.55ab	13.70abc	13.1def
4-E1140	1.4	1.8	1.3	18.8c	19.3c	14.6bcd	14.12b	13.99bc	12.9cde
5-80RM Select O.P.	1.4	1.8	1.4	18.1bc	16.7c	12.3abc	12.68a	12.67a	12.1ab
6-40I66 O.P.	1.3	1.8	1.7	13.6b	11.5ab	10.9ab	13.52ab	13.45abc	12.5bc
7-40K68	1.6	2.0	1.8	16.9bc	17.2c	14.3bcd	12.55a	13.21ab	11.6a
8-40I69	-	-	-	17.7bc	15.4bc	13.4bcd	13.57ab	13.79abc	12.6bcd
9-40K6 O.P.	-	-	-	7.4a	7.8a	8.1a	14.23b	14.33bc	13.2def
10-WS76(ID) · ACH30(ND) (Check)	1.6	2.1	1.3	17.9c	15.1bc	16.0cd	14.28b	14.49c	13.6f
F	0.49ns	0.31ns	1.41ns	8.01**	8.47**	3.68**	2.88**	2.75**	8.05**
C.V.	32.21	34.90	28.12	21.69	22.27	31.35	7.43	6.69	4.51

1/ Yield presented is adjusted for percentage tare.
2/ T = treated, U = untreated.
3/ Means not followed by the same letter are significantly different P < .05 as compared by a Duncan's multiple range test. ** = significant P < .01, * = significant P < .05, ns = nonsignificant, C.V. = coefficient of variation.

VI. INSECT STUDIES

COMPARISON OF SUGARBEET AND SEVERAL WEEDS AS HOSTS FOR BEET LEAFHOPPER AND BEET CURLY TOP VIRUS

D. L. Mumford and D. L. Doney

The beet leafhopper overwinters and produces initial spring populations almost exclusively on weed hosts in central California. The severity of curly top in commercial crops is probably related to the concentration of beet curly top virus (BCTV) in these initial leafhopper populations. The percentage of leafhoppers in these initial populations that carry BCTV is dependent on the extent of infection in the weed hosts on which they are produced. Since these factors are so important in the occurrence of disease outbreaks, information was obtained comparing sugarbeet with several weeds as hosts for beet leafhopper and BCTV. In 1957, Douglas and Hallock (2) reported differences in number of eggs deposited by beet leafhoppers in several weeds grown in the greenhouse. Although much is known about the weed host range of beet leafhopper and BCTV (1), most of the information is based on field observations. The purpose of this study was to compare the most important spring weed hosts in central California as hosts for beet leafhopper and BCTV under controlled greenhouse conditions. One of the major curly top control efforts is directed toward reducing leafhopper populations during this spring period. Information on the role of specific weed hosts should be helpful in setting priorities for this control program.

Materials and Methods

Five major weed hosts of the beet leafhopper in the foothill breeding areas of central California are Filaree (*Erodium cicutarium*), Plantago (*Plantago erecta*), Peppergrass (*Lepidium nitidum*), London Rocket (*Sisymbrium sp.*) and Russian Thistle (*Salsola kali tenicifolia*). Seedlings used for leafhopper production were grown for six to nine weeks until they were large enough to cage 10 adult leafhoppers on them without showing noticeable injury. Seedlings used for curly top inoculation were grown for four to six weeks. In both of the above instances, planting date of each species was varied to produce seedlings of comparable size.

Leafhopper production was measured by caging ten female leafhoppers on each plant for 30 days so that the leafhoppers had complete access to the entire plant. Plants were maintained in a greenhouse with 16-hour days and 8-hour nights. Day length was extended by use of fluorescent lighting for approximately four hours. Temperatures varied from a nighttime low of 18C to a daytime high of 34C. After 30 days, the number of nymphs was counted on each plant and the plant was weighed. Eight to 10 plants of each species were used for each test. Three tests were conducted.

Susceptibility to infection by BCTV was measured by caging four viruliferous leafhoppers on each plant for five days. The leafhoppers were caged on the plants in such a way that they had complete access to the entire plant. Leafhoppers were removed and the plants were kept in the greenhouse for 30 days to allow symptom development. Percentage infection was determined by visual observation, then each plant was assayed for virus content by enzyme-linked

immunosorbent assay (ELISA). Eight to 10 plants of each species were used for each inoculation test. Three tests were conducted. Plants were considered infected if either visual symptoms or the laboratory assay were positive. Tests were considered as replicates in the analysis of variance.

Results and Discussion

Beet leafhopper production was highest on sugarbeet and London Rocket (Table 1). Peppergrass plants survived in only one test and had high production. Plantago was intermediate. Filaree and Russian Thistle had the lowest leafhopper production. When data on leafhoppers produced per plant rather than per gram of host tissue was considered, results were similar to those in Table 1 except variability was greater.

Sugarbeet had a higher percentage infection with BCTV than any of the weed hosts tested, although it was not significantly higher than Filaree. Peppergrass and Plantago were intermediate in susceptibility with Peppergrass being significantly more susceptible. London Rocket and Russian Thistle had little or no infection.

There were some major differences in how the weed hosts responded to infection and leafhopper production. Filaree was one of the most susceptible to BCTV infection but was the lowest in leafhopper production. London Rocket was one of the least susceptible to infection but was the highest in leafhopper production. Differences such as these should be considered when directing leafhopper control efforts.

These results were obtained under very specific conditions. Leafhoppers did not have free choice of hosts on which to feed-inoculate or to lay eggs. Therefore, vector preference was not a factor. However, the treatment of different hosts was similar so information comparing reaction of different hosts under uniform conditions of virus inoculation and leafhopper production was obtained. Future tests may allow for vector preference and additional virus strains may be utilized.

The results show that under controlled conditions, there are major differences in beet leafhopper production and susceptibility to BCTV among the principle weed hosts in central California. The observations provide additional factors to be considered by those implementing control measures in this area.

Table 1. Comparison of beet leafhopper production and susceptibility to beet curly top virus infection on sugarbeet and five weed hosts.

Host	Percentage infection	Nymphs/gm host tissue
Sugarbeet	92	28
Filaree	88	6
Peppergrass	57	-
Plantago	28	10
London Rocket	5	24
Russian Thistle	0	6
LSD (5%)	23	18

Literature Cited

1. Bennett, C. W. 1971. The curly top disease of sugarbeet and other plants. Am. Phytopathol. Soc. Monograph No. 7.

2. Douglas, J. R., and H. C. Hallock. 1957. Relative importance of various host plants of the beet leafhopper in southern Idaho. U.S. Dept. Agr. Tech. Bull. 1155. 11p.

VII. POTENTIAL ALCOHOL FUEL RESEARCH

J. C. Theurer and D. L. Doney

A. NATIONAL COOPERATIVE FUEL BEET TRIALS

In 1980 and 1981, an intensive effort was made to evaluate the merit of European fodder beets for their potential use as a feedstock for alcohol fuel production. Particularly in 1981, we compared the merit of fodder beets vs. U.S. sugarbeet commercial cultivars for potential ethanol production at six U.S. locations. Results of these tests showed that the commercial sugarbeet hybrids would produce as much or more total fermentable sugar as any of the European fodder beet hybrid varieties. In addition, sugarbeets were more resistant to prevalent diseases and less total biomass would have to be transported for the equivalent alcohol yield. We also noted that the highest yielding fodder beets were actually hybrids with sugarbeet. Thus, we concluded that probably the optimum fuel beet would be a sugarbeet X fodder beet hybrid.

The 1982 national field trials were established to evaluate hybrids that were made by crossing U.S. sugarbeet CMS lines with European diploid fodder beets. Field trials were conducted this year as in previous years at six locations. These locations and the cooperating scientists at each location are shown below:

Location	Cooperating Scientist
Logan, Utah and Aberdeen, Idaho	Drs. J. C. Theurer and D. L. Doney, Research Geneticists
Salinas, Calif.	Dr. R. Lewellen, Research Geneticist
Fort Collins, Colo.	Dr. G. Smith, Research Geneticist
East Lansing, Mich.	Dr. G. J. Hogaboam, Research Geneticist
Fargo, N. Dak.	Dr. W. M. Bugbee, Research Plant Pathologist

Materials and Methods

Experimental Design: The experiment was planted at each location in six replications of a random block design. Individual plots consisted of four rows, approximately 6 m (20 feet) long or two rows, 11 m (37 feet) long, and a standard row width of 56 cm or 71 cm (22 or 28 inches) normally used for sugarbeets at the specific location. At the 4- to 6-leaf stage of development, plots were thinned to leave a single plant every 20 to 30 cm (8 to 12 inches) within the row. Planting dates and harvest dates were as follows:

	Logan	Aberdeen	Ft. Collins	Salinas	E. Lansing	Fargo
Planting Date	May 13	April 22	April 21	April 29	May 12	May 7
Harvest	Oct 12	Oct 18	Oct 7	Oct 27	-	Sep 28

Cultural Practices: Fertilizer and irrigation were the standard practices for growing sugarbeets at each location. Herbicide application was used at Fort Collins, Salinas, and Fargo for weed control. A weekly spray program with malathion was used at Logan as a means of precluding curly top disease. Fort Collins experienced a delay in seed germination and emergence due to a lack of precipitation at planting and inability to irrigate because of breaks and repairs being made on the Experiment Station Water System. In addition, another month of relatively cold weather resulted in a short growing season at this location.

The experiment at East Lansing was planted on land that had previously been used as a test site for an experiment to evaluate the effects of zinc on another crop. Zinc toxicity resulted in very poor stands at this location. Salinas had an excellent stand. At other locations, stand was fair to good.

Varieties: On the basis of 1981 mid-season appearance at Logan, eight fodder beet diploids were selected as pollinators for experimental fuel beet hybrids. Each was to be crossed with four CMS lines in contracted 1981-82 overwinter seed plots at St. George, Utah. Ten of these crosses produced sufficient seed to be included in the national test. Dr. Garry Smith developed five sugarbeet X fodder beet hybrids at Fort Collins with sufficient seed to evaluate at two to six locations. Thus a total of 15 new varieties were evaluated in these experiments. GWD2 was planted at each location as a standard check. There were twenty entries in the tests at Logan and Fort Collins. These consisted of all 15 new hybrids, three commercial cultivars, a high yield fodder beet check, and an old high yield-low quality variety, GWT6, furnished by Great Western Sugar Co. The Salinas trial had 14 new hybrids, two fodder beet checks, GWT6, and three commercial cultivars. At Aberdeen, the test consisted of 13 new hybrid varieties, GWT6, and three commercial sugarbeet cultivars. Nine new hybrids, two high yielding fodder beet checks, and three sugarbeet commercial cultivars, a total of 14 entries, were planted at East Lansing. The Fargo test was similar to East Lansing but included two additional commercial sugarbeet cultivars. The varieties at each location are given in Table 1.

Personnel at Logan packaged the seed of each variety and sent them to the various locations prior to planting. Each cooperator randomized their own field plan and planted the experiment.

Harvest and Laboratory Procedures: Beets were dug, cleaned, and topped by removing all of the green from the crowns and leaving the crowns intact with the root. Roots were immediately weighed and 10^{+} beets from each plot were utilized to evaluate sucrose percentage. Percent sucrose was determined by the cold digestion method for the Logan, Aberdeen, and Salinas locations, and by the thin juice method at Fort Collins and Fargo. Amino N, Na, and K content were determined at Logan and Aberdeen locations using standard laboratory techniques. Reducing sugars (glucose and fructose) were not quantified this year because of tight budgets and because reducing sugar was less than 1 percent for any variety studied during 1980 and 1981.

Data Summary and Statistical Analysis: Raw data was transcribed on a series of data sheets for each location and sent to Logan for statistical analysis and summarization of the research project.

Results

Data from five locations has been analyzed, summarized, and is presented here. The loss of all beets in areas of the field where high zinc treatments had been previously resulted in abandonment of the East Lansing test. F tests of the analyses of variance for root yield, sucrose percent, and total sugar yield at Fargo were all non-significant and the C. V. values at this location were higher than usually observed. Yield and quality factor data is summarized in Table 2 for Logan, Table 3 for Aberdeen, Table 4 for Salinas, Table 5 for Fort Collins, and Table 6 for Fargo Locations.

Root Weight: The root weight averaged from 43 t/ha at Fargo (Table 6) to 96 t/ha at Salinas (Table 4). None of the new hybrids significantly exceeded the highest sugarbeet cultivar (GWH149) at Logan (Table 2). This commercial was significantly superior to four of the new hybrids for root yield. CMS10 X Giant Half Sugar, and CMS20 X Giant Half Sugar had highest root yield at Aberdeen (Table 3). The Lamono fodder beet check was also among the highest in root yield at this location. All new hybrids except CMS10 X Giant Half Sugar were either equal to or significantly lower in root yield than GWH149 commercial. The fodder beet check varieties were significantly better in root yield at Salinas (Table 4) than all other entries. Ten of the new hybrids were significantly higher than USH11. The Lamono fodder beet check had 22 t/ha more root weight than the best other entry at Fort Collins (Table 5). Eight of the new hybrids were significantly higher in root yield than GWD2 or GWE4 varieties at this location.

Sucrose Percentage: The sugarbeets were higher in sucrose percentage than the new sugarbeet X fodder beet varieties at every location. However, there were five of the new hybrids, CMS8 X Oscar, CMS8 X Solar, CMS10 X TC5/45-9, FC608 X Krake, and FC608 X Monorosa that were relatively consistent across locations in having sugar content that was not significantly different from that of the sugarbeet cultivars. Sucrose is inherited in an additive manner and is usually equal to the mean of the parents. The sucrose percentage for these lines is far above that of the parent means. At present, we do not have a good reason to explain these results.

Sugar yield: On the average, sugar yield ranged from a low of 4.7 t/ha at Fort Collins (Table 5) to a high of 12.5 t/ha at Salinas (Table 4). At Logan (Table 2) GWH149 produced 12.7 t/ha sugar, which was significantly greater than the sugar yield of any of the new sugarbeet X fodder beet hybrids. There was very little difference among the new hybrids at Aberdeen (Table 3). The sugarbeet commercial varieties were all significantly higher in sugar than the fodder beet X sugarbeet hybrids there.

GWT6 had significantly the highest sugar yield at both Fort Collins (Table 5) and Salinas (Table 4). Eight of the new hybrids were significantly lower in sugar yield than USH11 at Salinas. GWD2 and GWE4 sugarbeet cultivars were also significantly superior to the new hybrids in sugar yield at Fort Collins.

Quality Factors: Quality factors were measured for the varieties grown at Logan and Aberdeen (Tables 2 and 3). There was little difference between the sugarbeet X fodder beet hybrids and the commercial sugarbeet cultivars for amino nitrogen. However, the new hybrids generally showed for greater sodium and potassium impurities than the sugarbeets. The impurity index was also slightly

Table 1. Fodder beet X sugarbeet hybrids and commercial sugarbeet cultivars in the 1982 national cooperative research experiment.

Variety	Logan	Aberdeen	Salinas	Ft. Collins	East Lansing	Fargo
FB X SB Hybrid						
CMS6 X Giant Half Sugar	X	X	X	X		
CMS8 X "	X	X	X	X	X	X
CMS10 X "	X	X	X	X		
CMS20 X "	X	X	X	X	X	X
CMS6 X Camobarres	X	X	X	X		
CMS8 X "	X	X	X	X	X	X
CMS8 X Solar	X	X	X	X	X	X
CMS8 X Oscar	X	X	X	X	X	X
CMS20 X "	X	X	X	X	X	X
CMS10 X TC5/45-9	X	X	X	X	X	X
FC607CMS X Peramono	X	X	X	X	X	X
FC606CMS X "	X		X	X		
FC608CMS X "	X	X	X	X		
FC608CMS X Krake	X			X		
FC608CMS X Monorosa	X	X	X	X	X	X
FB Check						
Lamono	X	X	X	X	X	X
Monovigor			X		X	X
Sugarbeet Cultivars						
GWD2	X	X	X	X	X	X
GWT6	X	X	X	X		
Local Check	GWH149	GWH149	USH11	GWE4	USH23	Monova
Local Check	WS76	Beta9421	Holly 7334-05	Beta1237	HH33	Hilleshog309 GWR107 ACH30

Table 2. Root weight, sucrose percentage, sugar yield, potential alcohol yield, amino N, Na, K, and impurity index for sugarbeet X fodder beet hybrids, Logan, Utah 1982.

Variety	Root weight t/ha	Sucrose %	Sugar yield t/ha	Potential alcohol yield[1/] kl/ha	Amino N ppm	Na ppm	K ppm	Impurity Index
CMS6 X Giant Half Sugar	88.11	12.1	10.66	6.35	618	455	1897	1043
CMS8 X "	83.40	11.5	9.55	5.68	703	381	2064	1182
CMS10 X "	91.03	11.4	10.42	6.20	484	357	2052	982
CMS20 X "	89.01	11.7	10.42	6.20	623	395	1862	1048
CMS6 X Camobarres	77.57	12.3	9.55	5.68	557	231	1722	872
CMS8 X "	77.35	13.1	10.06	5.99	608	221	1587	858
CMS8 X Solar	73.09	13.7	9.97	5.93	603	263	1520	788
CMS8 X Oscar	65.02	14.4	9.33	5.55	480	229	1302	618
CMS20 X Oscar	87.21	12.5	10.87	6.47	658	330	1843	991
CMS10 X TC5/45-9	62.33	14.1	8.78	5.23	610	260	1445	752
FC607CMS X Peramono	79.82	11.7	9.36	5.57	713	411	1960	1148
FC606CMS X "	80.49	11.6	9.33	5.55	588	386	2243	1084
FC608CMS X "	79.92	11.4	9.03	5.38	687	340	2072	1160
FC608CMS X Krake	66.36	14.0	9.32	5.55	518	178	1604	699
FC608CMS X Monorosa	74.43	12.9	9.58	5.70	621	253	1679	879
Lamono II	81.38	11.3	9.23	5.49	564	495	2064	1114
GWT6	80.26	14.8	11.83	7.04	673	247	1677	798
GWD2	79.59	15.0	11.96	7.12	641	150	1485	711
GWH149	84.30	15.0	12.66	7.54	577	137	1416	652
WS76	78.25	14.9	11.63	6.92	578	194	1879	753
Mean	78.92	13.0	10.18	6.06	606	296	1769	907
LSD .05	8.61	0.6	1.19	0.71	115	83	577	217
C. V.	9.5	4.2	10.1	10.1	16.5	24.3	14.3	20.8

[1/] 1.68 kg sugar = 1 liter alcohol. Multiply kl/ha by 106.9 = gal/acre.

Table 3. Root yield, sucrose percentage, sugar yield, potential alcohol yield, Amino K, Na, K, and impurity index for sugarbeet X fodder beet hybrids, Aberdeen, Idaho, 1982.

Variety	Root weight t/ha	Sucrose %	Sugar yield t/ha	Potential alcohol yield [1] kl/ha	Amino N ppm	Na ppm	K ppm	Impurity index
CMS6 X Giant Half Sugar	75.10	9.8	7.34	4.37	497	1146	3010	1764
CMS8 X "	77.73	8.8	6.82	4.06	482	1674	2760	1988
CMS10 X "	87.21	9.2	7.98	4.75	484	1155	2964	1813
CMS20 X "	85.67	9.1	7.77	4.63	530	1865	2856	2089
CMS6 X Camobarres	75.58	10.6	8.00	4.76	529	899	2493	1392
CMS8 X "	57.70	11.0	6.39	3.80	461	916	2347	1250
CMS8 X Solar	56.99	13.7	7.82	4.65	531	766	2208	987
CMS8 X Oscar	50.62	14.4	7.28	4.33	545	845	2116	956
CMS20 X "	71.99	9.3	6.70	3.99	467	1200	2710	1689
CMS10 X TC5/49-9	54.59	13.7	7.47	4.45	402	593	2237	859
FC607CMS X Peramono	73.29	9.2	6.76	4.02	460	1818	2885	2009
FC608CMS X "	73.78	9.3	6.81	4.05	483	1506	2858	1868
FC608CMS X Monorosa	64.66	10.9	7.06	4.18	547	1023	2693	1463
Lamono II	85.06	8.4	7.15	4.26	540	1759	2689	2272
GWT6	65.15	13.4	8.74	5.20	552	774	2783	1316
GWD2	71.39	14.6	10.39	6.18	452	593	2397	868
GWH149	76.65	15.4	11.81	7.03	558	471	2197	830
Beta 9421	68.98	15.3	10.56	6.29	449	590	2268	802
Mean	70.67	11.4	7.94	4.73	499	1089	2582	1457
LSD 0.05	10.22	1.0	1.31	0.78	88	437	394	336
C. V.	12.7	7.5	14.4	14.4	15.4	35.1	13.3	20.2

[1] 1.68 kg sugar = 1 liter alcohol. Multiply kl/ha by 106.9 = gal/acre.

Table 4. Root weight, sucrose percentage, sugar yield, and potential alcohol yield of sugarbeet X fodder beet hybrids at Salinas, Calif., 1982

Variety	Root weight t/ha	Sucrose %	Sugar yield t/ha	Potential alcohol yield kl/ha[1/]
CMS6 X Giant Half Sugar	105.52	12.1	12.75	7.59
CMS8 X "	103.70	12.3	12.68	7.55
CMS10 X "	105.32	11.8	12.40	7.38
CMS20 X "	108.06	11.0	11.92	7.10
CMS6 X Camobarres	97.11	12.5	12.16	7.24
CMS8 X "	92.84	12.7	11.75	6.99
CMS8 X Solar	77.07	15.2	11.67	6.95
CMS8 X Oscar	68.90	16.3	11.20	6.67
CMS20 X "	94.19	11.9	11.22	6.68
FC607CMS X TC5/45-9	72.67	15.3	11.12	6.62
FC606CMS X Peramono	109.72	11.6	12.74	7.58
FC608CMS X "	107.37	11.7	12.52	7.45
FC608CMS X "	108.57	10.6	11.46	6.82
FC608CMS X Monorosa	88.56	14.4	12.72	7.57
Monovigor	126.21	10.8	13.56	8.07
Lamono II	117.70	11.9	13.99	8.33
GWT6	91.18	16.5	15.06	8.96
GWD2	78.10	16.1	12.61	7.51
USH11	82.46	16.1	13.24	7.88
Holly 7334-05	80.56	16.7	13.45	8.01
Mean	95.79	13.4	12.53	7.46
LSD 0.05	6.78	0.8	1.07	0.64
C. V.	6.18	5.13	7.48	7.48

[1/] 1.68 kg sugar = 1 liter alcohol. Multiply kl/ha by 106.0 = gal/acre.

Table 5. Root yield, sucrose percentage, sugar yield, and potential alcohol yield of sugarbeet X fodder beet hybrids, Fort Collins, Colo., 1982.

Variety	Root weight t/ha	Sucrose %	Sugar yield t/ha	Potential alcohol yield kl/ha[1/]
CMS6 X Giant Half Sugar	65.56	6.8	4.44	2.64
CMS8 X "	69.71	6.1	4.23	2.52
CMS10 X "	69.78	6.5	4.44	2.64
CMS20 X "	73.56	6.3	4.60	2.74
CMS6 X Camobarres	58.83	7.5	4.44	2.64
CMS8 "	57.29	7.7	4.37	2.60
CMS8 X Solar	40.36	10.1	4.07	2.42
CMS8 X Oscar	36.27	10.8	3.90	2.32
CMS20 X "	63.57	6.5	4.13	2.46
CMS10 X TC5/45-9	38.66	10.1	3.89	2.32
FC607CMS X Peramono	67.41	6.4	4.16	2.48
FC606CMS X Peramono	71.52	6.1	4.25	2.53
FC608CMS X Peramono	70.44	6.6	4.55	2.71
FC608CMS X Monorosa	52.60	8.5	4.44	2.64
FC608CMS X Krake	47.66	10.1	4.81	2.86
Lamono II	96.05	4.7	4.47	2.66
GWT6	61.31	10.8	6.62	3.94
GWD2	51.22	11.6	5.87	3.49
GWE4	52.34	12.2	6.37	3.79
Beta 1237	49.10	10.3	5.01	2.98
Mean	59.66	8.3	4.65	2.77
LSD 0.05	9.43	1.2	0.75	0.45
C. V.	13.7	12.6	13.9	13.9

[1/] 1.68 sugar = 1 liter alcohol. Multiply kl/ha by 106.9 = gal/acre.

Table 6. Root yield, sucrose percentage, sugar yield, and potential alcohol yield of sugarbeet X fodder beet hybrids, Fargo, N. Dak., 1982.

Variety	Sugar yield t/ha	Root weight t/ha	Sucrose %	Potential alcohol yield kl/ha[1/]
CMS8 X Oscar	7.10	53.68	13.5	4.23
CMS8 X Camobarres	6.18	37.35	16.6	3.68
CMS8 X Giant Half Sugar	6.17	40.82	15.5	3.67
CMS8 X Solar	6.69	48.97	13.6	3.98
CMS10 X TC5/49-5	5.84	41.04	14.2	3.48
CMS20 X Oscar	6.06	47.46	13.6	3.71
CMS20 X Giant Half Sugar	6.35	43.83	14.7	3.78
FC607CMS5 X Peramono	6.15	39.86	15.4	3.66
FC608CMS X Monorosa	6.50	47.48	14.5	3.87
Lamono	6.18	41.82	14.9	3.68
Monovigor	6.19	45.10	14.2	3.68
GWD2	6.35	43.82	15.0	3.80
Monovà	6.32	40.51	16.2	3.76
Hilleshog 309	5.68	35.62	16.0	3.38
GWR107	6.06	38.39	15.9	3.61
ACH30	7.35	50.09	14.8	4.38
Mean	6.32	43.49	14.9	3.76
LSD 0.05	1.45	13.56	2.3	0.86
C. V.	20.0	27.1	13.2	20.0

[1/] 1.68 kg sugar = 1 liter alcohol. Multiply kl/ha by 106.9 = gal/acre.

higher for the fodder beet hybrids. The GWT6 sugarbeet variety had impurity components similar to that of the fodder beet hybrids.

Potential Alcohol Yield: The potential alcohol yield is calculated from the total sugar yield, so the results are similar. Based on 1.68 kg sugar per liter of alcohol, the predicted amount of ethanol ranged from 2 to 9 kl/ha during this season. Fort Collins and Fargo had the lowest estimates and Salinas the highest. The sugarbeet cultivars had the greatest potential for fuel beet.

Discussion

Results from the 1982 tests tend to confirm data of the previous two years. Lamono and Monovigor fodder beet check varieties demonstrated high root yield and low sugar content for fodder beets that we had observed before. The commercial cultivars or the old variety GWT6 have better potential for alcohol fuel production than the new fodder beet X sugarbeet hybrids. However, we must recognize that the fodder beet pollinators were not evaluated other than visual observation prior to their use in these new hybrids. Based on yield performance trials, there are other fodder beet lines that may have better potential than those used for pollinators in this study. With 1982 data, we would still continue to conclude as was done last year, that the best fuel beet at present is an adapted disease resistant commercial cultivar. Considerable selection and breeding appears necessary to develop a better fuel beet than the sugarbeet varieties that are presently being grown.

B. INTERMOUNTAIN FUEL BEET FIELD TRIALS

Two other fuel beet experiments were planted in 1982. These consisted of new hybrids where there was only sufficient seed to field test at one or two locations. One test of 14 sugarbeet hybrids and three commercial check varieties was planted at Logan and Aberdeen. Another test of 17 new sugarbeet X fodder beet hybrids was planted at Logan. Each test consisted of six replications. Individual plots were two rows, 56 cm (22 inches) apart and approximately 11 m (37 - 38 feet) long. All plants were harvested for root weight and sucrose, and quality factors were determined by standard laboratory methods. Potential alcohol yield was estimated on the basis of 1.68 kg sugar for a liter of alcohol.

Results

Stands in the Logan experiments and in three replications at Aberdeen were not good. Some varieties were far more affected than others. Seed quality and quantity accounted for some of the poor stand. At Logan, there was seedling emergence problems mainly due to a residual chemical used for weed control in a previous crop. An early spring frost about the time of seed emergence was the main factor reducing stand in three replications at Aberdeen.

However, the results of these field trials parallel the results cited in the former section for the varieties in the national cooperative fuel beet trial. None of the new sugarbeet X fodder beet hybrids showed superiority over the

commercial sugarbeet varieties at either location (Tables 7, 8, and 9). GWH149 had an excellent stand in all of the trials and part of its superior sugar yield could be attributed to this factor. This variety has been among the better sugar yield varieties in field tests in Utah and Idaho for the past three years.

Sugar percentage was significantly lower for all sugarbeet X fodder beet hybrids than observed for the sugarbeet cultivars.

Five of the new inbreds involving U.S. female parents (20♀ X Rota, (L20 X L50) X Rota, (L20 X L50) X Jaune de vauriac, 20♀ X Solar, L53 X Pajbjerg Korsroe) had significantly higher sugar yield than the European varieties Lamono II or Monriac (Table 9). The latter two varieties were among the highest yielding fodder beet varieties in 1980 and 1981 tests and were included in this trial as checks. CMS20 X Pajbjerg Korsroe was significantly higher than either Lamono I or Monriac at both Logan and Aberdeen (Tables 7 and 8). At Aberdeen (Table 7), CMS10 X Camobarres, CMS20 X Camobarres, and (C16 X 37G3) X Jaune de Vauriac, were also significantly higher in sugar yield than the European fodder beet checks.

On the average, the quality or impurity factors and the impurity index was higher for the fodder beet X sugarbeet hybrids, than for the sugarbeet commercials. Sodium ranged from 100 to 300 percent higher than the sugarbeet checks. Potassium content was 100 to 140 percent higher than that of the checks.

Potential alcohol yield ranged from 5.22 kl/ha to 7.93 kl/ha (558-848 gal/acre) in one Logan test (Table 9) and 4.73 kl/ha to 7.11 kl/ha (506 - 760 gal/acre) in the other (Table 8). At Aberdeen, the range was 3.31 kl/ha to 7.06 kl/ha (354-755 gal/acre) (Table 7).

These results support data from other fuel beet evaluation trials. They point out that improvement in a fuel beet, over the standard sugarbeet commercial, will have to be obtained by breeding and selection specifically for a fuel beet.

Table 7. Root yield, sucrose percentage, sugar yield, quality factors, and potential alcohol yield of sugarbeet X fodder beet hybrids, Aberdeen, Idaho, 1982 (Test 10).

Code/Variety	Root weight	Sucrose %	Gross sugar yield	Potential alcohol yield kl/ha[1/]	Amino N ppm	Na ppm	K ppm	Impurity Index
GWH149	79.06	15.0	11.87	7.06	461	458	2406	817
Beta 9421	67.91	14.5	9.90	5.89	441	532	2358	843
WS76	67.91	15.3	9.13	5.43	450	454	2245	772
CMS8 X Monoparte	56.15	12.8	7.20	4.29	448	869	2239	1029
CMS10 X Camobarres	81.82	11.1	9.07	5.40	466	890	2758	1334
CMS20 X "	82.90	10.9	8.96	5.33	538	663	2258	1252
CMS10 X Solar	69.23	10.6	7.32	4.36	501	935	2433	1369
CMS10 X Geante Rouge	86.98	8.1	7.07	4.21	466	1607	2852	2147
CMS20 X Geante Blanche	86.74	8.6	7.47	4.45	479	1258	2483	1798
CMS10 X Rose des Ardenis	87.22	8.3	7.24	4.31	506	1528	3133	2220
(C16 X 37G3) X Jaune de Vauriac	72.59	12.1	8.76	5.21	451	786	2475	1125
CMS10 X Giant Half Sugar	78.94	9.2	7.22	4.30	474	1370	3002	1859
CMS10 X Winter Gold	88.18	8.8	7.83	4.66	507	1176	3170	1964
CMS10 X Pajbjerg Korsroe	83.38	11.6	9.63	5.73	467	731	2506	1169
CMS10 X Rota	84.58	9.5	8.00	4.76	437	1036	3058	1658
Lamono II	86.24	7.9	6.81	4.05	470	1446	2679	2093
Monriac	84.52	6.6	5.56	3.31	468	1629	2787	2749
Mean	79.08	10.6	8.25	4.91	473	1022	2638	1542
LSD 0.05	3.9	1.1	1.19	0.71	105	419	474	321
C. V.	9.6	8.6	12.6	12.6	19.5	35.8	15.7	18.2

[1/] 1.68 kg sugar = 1 liter alcohol. Multiply kl/ha by 106.9 = gal/acre.

Table 8. Root yield, sucrose percentage, sugar yield, quality factors, and potential alcohol yield of sugarbeet X fodder beet hybrids, Logan, Utah, 1982 (Test 9).

Code/Variety	Root weight t/ha	Sucrose %	Sugar yield t/ha	Potential alcohol yield kl/ha[1]	Amino N ppm	Na ppm	K ppm	Impurity Index
GWH149	77.80	15.4	11.94	7.11	645	191	1345	684
Beta 9421	72.87	14.8	10.81	6.43	557	225	1539	690
WS76	74.66	15.3	11.45	6.82	615	196	1422	680
CMS8 X Monoparte	55.83	12.7	7.11	4.23	544	361	1600	851
CMS10 X Camobarres	71.07	12.5	8.88	5.29	462	333	1577	779
CMS20 X "	72.19	12.6	9.13	5.43	535	337	1516	826
CMS10 X Solar	69.95	12.7	8.86	5.27	596	260	1577	852
CMS10 X Geante Rouge	82.28	11.0	9.08	5.40	691	440	2075	1250
CMS20 X Geante Blanche	75.11	10.9	8.19	4.88	581	452	1670	1066
CMS10 X Rose de Ardenis	76.90	10.7	8.24	4.90	663	407	1764	1167
(C16 X 37G3) X Jaune de Vauriac	68.61	12.9	8.82	5.25	576	306	1606	841
CMS10 X Giant Half Sugar	79.37	11.6	9.18	5.46	612	384	1829	1051
CMS10 X Winter Gold	79.37	10.8	8.57	5.10	705	372	1858	1203
CMS20 X Pajbjerg Korsroe	77.57	13.1	10.20	6.07	562	356	1356	782
CMS10 X Rota	79.82	11.4	9.09	5.41	546	370	1752	981
Lamono II	77.80	10.5	8.19	4.88	565	506	1929	1172
Monriac	81.38	10.4	8.47	5.04	738	344	1943	1313
Mean	74.88	12.3	9.19	5.47	600.1	346.8	1668.5	952.8
LSD 0.05	10.11	.70	1.40	0.83	111.81	93.94	320.16	151.92
C. V.	11.8	5.0	13.2	13.2	16.2	23.6	16.7	13.9

[1] 1.68 kg sugar = 1 liter alcohol. Multiply kl/ha by 106.9 = gal/acre.

Table 9. Root yield, sucrose percentage, sugar yield, quality factors, and potential alcohol yield of sugarbeet X fodder beet hybrids, Logan, Utah, 1982 (Test 8).

Code/Variety	Root weight t/ha	Sucrose %	Sugar yield t/ha	Potential alcohol yield kl/ha[1/]	Amino N ppm	Na ppm	K ppm	Impurity index
GWH149	86.32	15.2	13.08	7.79	549	165	1500	647
Beta 9421	86.32	15.4	13.32	7.93	533	148	1585	637
WS76	81.38	15.4	12.53	7.46	581	146	1493	653
6♀ X Solar	73.54	13.8	11.05	6.58	633	250	1535	803
Monriac	88.11	10.6	9.31	5.54	738	381	2177	1343
20♀ X Red Otofte	74.66	13.5	10.06	5.99	696	286	1422	851
20♀ X Rota	86.99	12.5	10.91	6.49	721	337	1854	1046
20♀ X Geante Rouge	86.99	11.7	10.15	6.04	732	413	1972	1175
10♀ X Jaune de Vauriac	79.82	11.0	8.77	5.22	686	285	2191	1214
(L20 X L50) X "	78.92	14.2	11.24	6.69	648	228	1331	746
20♀ X Jaune de Vauriac	84.52	12.2	10.20	6.07	684	298	1787	1017
20♀ X Solar	76.23	13.9	10.62	6.32	661	293	1631	843
(L20 X L50) X Rota	77.35	14.8	11.44	6.81	481	240	1666	665
10♀ X Red Otofte	79.14	13.1	10.34	6.15	642	250	1897	920
L53 X Pajbjerg Korsroe	83.40	13.1	10.97	6.53	611	294	1866	894
L10 X Blanca	78.25	13.1	10.23	6.09	624	273	1654	870
L53 X Blanca	80.71	13.0	10.50	6.25	649	283	1556	874
Lamono I	82.28	11.0	9.08	5.40	602	404	1966	1126
TC5/45-9	88.56	10.7	9.43	5.61	580	360	2139	1169
TC5/45-9 OP	87.89	11.5	10.08	6.00	590	340	1893	1033
Mean	82.06	13.0	10.62	6.32	632.6	284.1	1756.3	926.8
LSD 0.05	10.38	.57	1.31	0.78	100.21	81.73	289.46	133.32
C. V.	11.0	3.81	10.7	10.7	13.8	25.0	14.3	12.5

[1/] 1.68 kg sugar = 1 liter alcohol. Multiply kl/ha by 106.9 = gal/acre.

VIII. PHYSIOLOGY-BIOCHEMISTRY

RELATIONSHIP BETWEEN SUCROSE ACCUMULATION AND TAPROOT ENZYME ACTIVITIES

Roger E. Wyse

The capacity to store sucrose in diverse genotypes of Beta vulgaris is related in major part to the morophology of the taproot. An inverse relationship exists between cell size, vascular density, and sucrose content (Doney et. al., 1981; Wyse, 1979). However, this relationship does not explain totally the variation in sucrose content. For example, when fodder beet types (large cells, low vascular density, low sucrose) are grown in high density plantings to reduce cell size and increase vascular density, the increased sucrose content does not equal that of sugar types with the same morophology (Wyse, 1980). From these results, it was concluded that other factors must be involved in determining sucrose content. This unknown factor is apparently not the ability of the tissue to take up sucrose because excised tissue discs incubated in dilute sucrose solutions take up sucrose at similar rates.

In this study, an attempt was made to determine if enzyme activity was somehow related to sucrose content during the first portion of the growing season.

Materials and Methods

Four genotypes (GWD2, commercial; Blanca, fodder type; L19 X L53, high sugar hybrid, and swiss chard) were planted in a replicated field trial on May 6, 1982. The plants emerged one week later and were thinned three weeks after emergence. Starting four weeks post-emergence, twenty plants were harvested from each plot at weekly intervals. Analyses of dry matter yields, sucrose, and reducing sugar contents were made. Enzyme activities of sucrose synthetase, acid, and neutral invertase were determined in taproot tissue (Wyse, 1974). These enzymes were selected because they are the key enzymes of sucrose metabolism in the taproot.

Results

Only taproot dry weight will be reported here. Root dry weight increased in a typical logarithmic fashion for Blanca, L53 X L19, and D2 (Figure 1). The linear growth pattern of the swiss chard was an obvious deviation from the other genotypes. The swiss chard root system is a combination of taproot and branched fibrous roots with the taproot representing a much lower proportion of the total root system than in the other genotypes. Therefore, a higher proportion of the root was lost during harvesting swiss chard. This may explain the anomalous growth pattern.

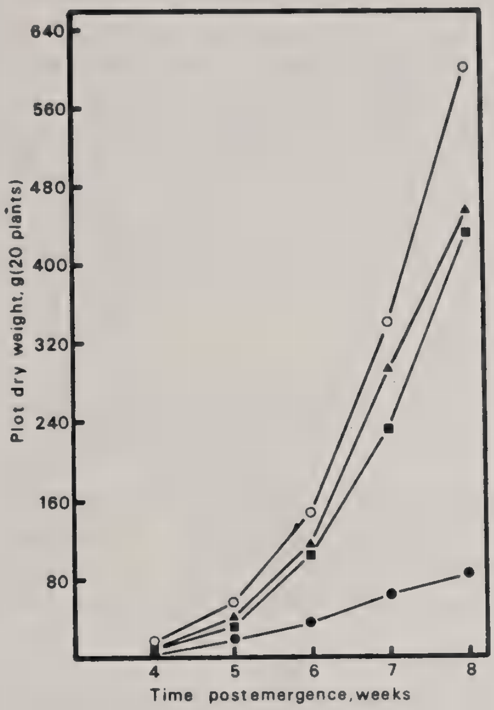

Figure 1. Taproot dry weight yield of four diverse genotypes of Beta vulgaris during the first eight weeks of the growing season (L53 X L19 (○), GWD2 (▲), Blanca (■), Swiss Chard (●).

Two forms of the sucrose hydrolyzing enzyme invertase exist in sugarbeet root. The so-called neutral form has a pH optimum for activity at pH 7. The acidic form has a pH optimum at 5.5.

Neutral invertase activity decreased during the period 4 to 6 weeks post-emergence but then began to increase again in all genotypes (Figure 2). Activity in swiss chard was lower at all times than activity in the other three genotypes.

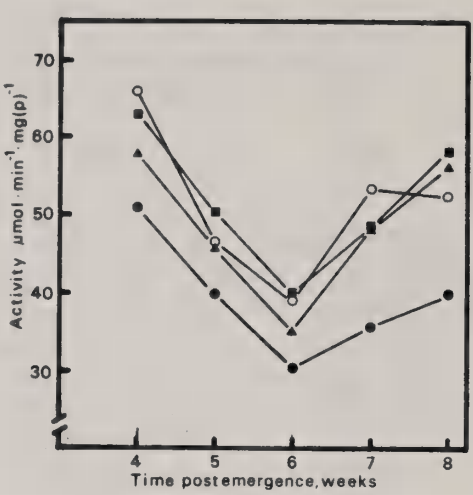

Figure 2. Neutral invertase activity in four diverse genotypes of Beta vulgaris. Activity is based on soluble protein content in the tissue (L53 X L19 (○), GWD2 (▲), Blanca (■), Swiss Chard (●).

Acid invertase was most active in the young seedlings and declined to near zero levels seven weeks after emergence (Figure 3). Swiss chard had a significantly higher activity over the period tested, particularly in the youngest seedlings.

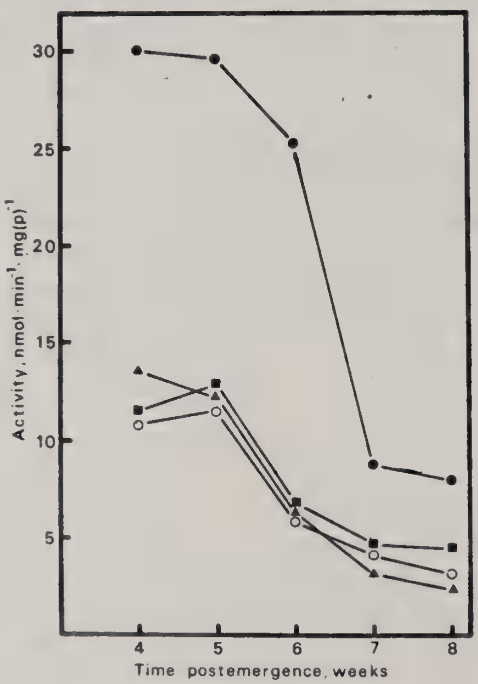

Figure 3. Acid invertase activity in four diverse genotypes of Beta vulgaris (L53 X L19 (○), GWD2 (▲), Blanca (■), Swiss Chard (●).

Sucrose synthetase is an easily reversible enzyme capable of both synthesizing and hydrolyzing sucrose. Because of this dual functionality, it is a possible regulatory point for controlling sucrose metabolism in non-green tissue. Sucrose synthetase activity (assayed as sucrose hydrolysis) varied greatly between the genotypes but increased with time (Figure 4). L53 X L19, a high sugar hybrid, had the highest activity followed by D2 and Blanca. Swiss chard was significantly lower at all times tested. Note the correlation between sucrose synthetase activity and sucrose content (Figure 6).

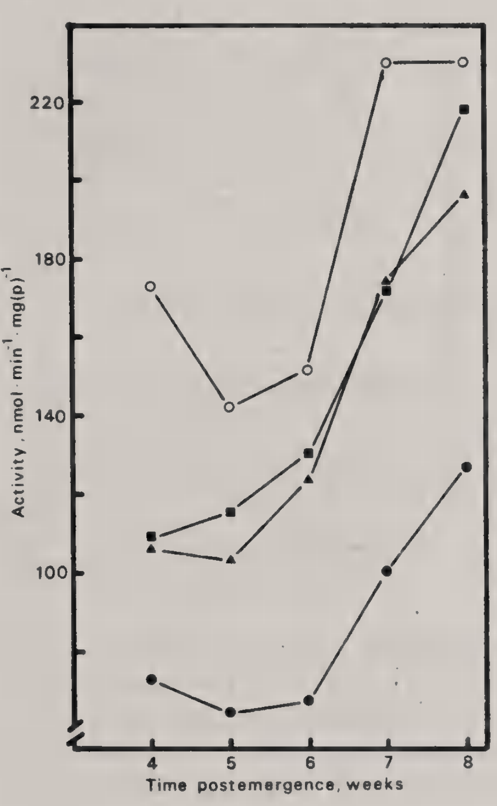

Figure 4. Sucrose synthetase activity in four diverse genotypes of Beta vulgaris (L53 X L19 (○), GWD2 (▲), Blanca (■), Swiss Chard (●).

During the period tested, D2 and Blanca had the same sucrose content and the same sucrose synthetase activity. Later, D2 (commercial sugar hybrid) will accumulate significantly more sucrose than Blanca.

The reducing sugars, glucose and fructose, were determined by HPLC analysis of an 80 percent ethanol extract. Reducing sugar levels declined over time with the sugar types having a lower content than swiss chard (Figure 5). The low content in Blanca was surprising because in previous studies we have found the reducing sugar content in fodder types to be higher than that in sugar types. The general decline in reducing sugars correlated with a decline in acid invertase activity.

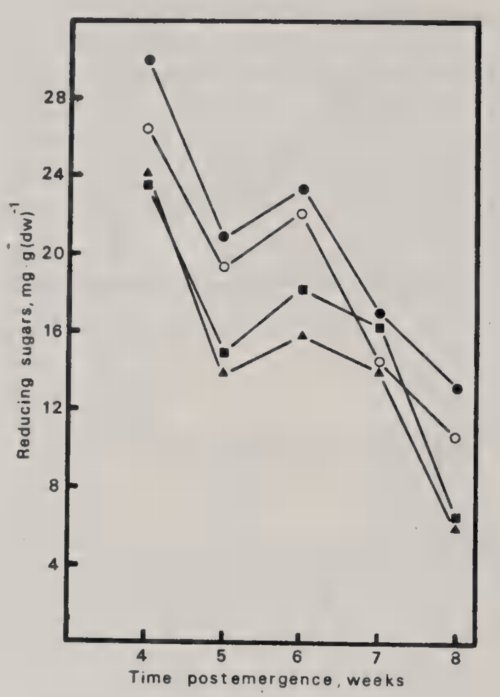

Figure 5. Reducing sugar content of four diverse genotypes of Beta vulgaris (L53 X L19 (○), GWD2 (▲), Blanca (■), Swiss Chard (●).

The sucrose content was determined by HPLC analysis of an ethanol extract (Figure 6). The high sugar hybrid, L53 X L19, had the highest sucrose content over the entire period studied. Surprisingly, D2 and Blanca had the same sucrose content until six weeks of age when the content of D2 continued to increase while Blanca leveled off. Swiss chard remained well below the other genotypes.

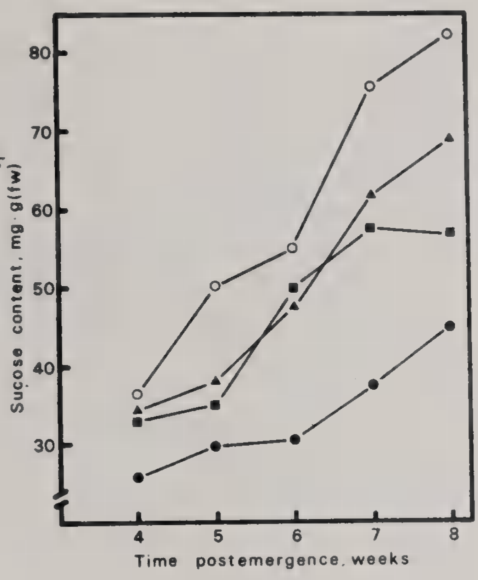

Figure 6. Sucrose content of four diverse genotypes of Beta vulgaris (L53 X L19 (○), GWD2 (▲), Blanca (■), Swiss Chard (●).

Conclusions

Sucrose accumulation was initiated when acid invertase declined, but the sucrose level in the tissue was correlated with sucrose synthetase activity. These data support the hypothesis that the sucrose storage capacity not explained by root morophology may be a function of sucrose synthetase activity. The data support, in part, the work of Silvius and Snyder (Silvius et. al., 1979 A, Silvius et. al., 1979 B, Silvius et. al., 1981). They found differences in the nucleotide substrate specificity of sucrose synthetase activity in fibrous and taproots. They proposed that the UDP preferance of the taproot synthetase enzyme was related to sucrose storage in that tissue.

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SUGARBEET RESEARCH

1982 Report

Section C

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CONTENTS

	Page
ABSTRACTS OF PAPERS	C3
RAPID SELECTION AND REGENERATION OF ELITE SUGARBEET GENOTYPES (BSDF Project 75)	
Screening and Regeneration of Elite Sugarbeet Genotypes via Tissue Culture Techniques by G. A. Smith and H. S. Moser.	C6
RHIZOCTONIA ROOT ROT RESEARCH AND RESISTANCE BREEDING (BSDF Project 20B)	
1982 Rhizoctonia Field Research by R. J. Hecker and E. G. Ruppel	C7
Evaluation of Contributed Lines by E. G. Ruppel and R. J. Hecker	C7
Evaluation of Rhizoctonia Inoculation Methods by E. G. Ruppel and R. J. Hecker.	C8
Evaluation of Germplasms in the Development of Resistance to Root-rotting Strains of *R. solani* by R. J. Hecker and E. G. Ruppel.	C10
Comparisons of Methods to Select for Resistance to *R. solani* by R. J. Hecker and E. G. Ruppel	C15
Combining Ability Test for Sucrose Yield or Rhizoctonia Resistant Experimental Hybrids by R. J. Hecker and G. A. Smith.	C18
Performance of Experimental Hybrids Involving Rhizoctonia Resistant Pollinators by R. J. Hecker and G. A. Smith. . .	C21
CERCOSPORA LEAF SPOT RESEARCH AND BREEDING FOR CERCOSPORA/CURLY TOP RESISTANCE (BSDF Project 25)	
1982 Cercospora Field Research by G. A. Smith and E. G. Ruppel	C23
Leaf Spot Evaluations of Sugarbeet Lines Submitted by BSDF-Member Companies by E. G. Ruppel and G. A. Smith. . .	C23
Breeding for Resistance to Cercospora and Curly Top Virus 1982 by G. A. Smith and E. G. Ruppel	C23
Persistence of Benomyl Tolerance and Absence of Triphenyltin Tolerance in *Cercospora beticola Isolates* from Texas by E. G. Ruppel	C29
SUGARBEET QUALITY IMPROVEMENT RESEARCH: GENETICS, PHYSIOLOGY AND METHODS (BSDF Project 53)	
Quality Improvement by Post-Storage Selection by R. J. Hecker, S. S. Martin, and G. A. Smith.	C30
Sodium, Potassium, and Amino N in Fodder Beets by S. S. Martin and G. A. Smith	C33
The Effect of Benomyl on Some Chemical Constituents of Sugarbeet by G. A. Smith and S. S. Martin.	C34
CLARIFICATION OF SUGARBEET EXTRACTS (BSDF Project 81)	
Sugarbeet Extract Clarification by S. S. Martin	C35

Page

OTHER RESEARCH OF INTEREST TO BSDF MEMBERS

The Evaluation of Sugarbeet Accessions from China for Cercospora and Rhizoctonia Resistance by G. A. Smith, R. J. Hecker and E. G. Ruppel C36

Development of a Trisomic Series in Homozygous Sugarbeet by R. J. Hecker and I. Romagosa C37

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION AND GERMPLASM RELEASES AND REGISTRATIONS 1982

HECKER, R. J. and E. G. RUPPEL. 1982. Release of sugarbeet germplasm FC 711. Officially released 10-13-82.

FC 711 is a multigerm, pollen fertile, self sterile sugarbeet (Beta vulgaris) germplasm resistant to root rot caused by Rhizoctonia solani. It is It is diploid (2x = 18) and segregates for pink and green hypocotyl color. FC 711 originated from two heterogeneous breeding lines from Japan. From these two original accessions, FC 711 was produced following four cycles of inoculation and intense selection for resistance to root rotting strains of R. solani. Under a severe artificially-created ephiphytotic in 1981 and 1982, FC 711 had a disease index of 2.9 (scale of 0 to 7) compared to 2.7 for FC 703 (resistant check) and 5.8 for FC 901 (susceptible check). With a set of 10 male sterile testers, the hybrids involving FC 711 had lower average sucrose production than several other resistant germplasms in the program, primarily as a result of lower sucrose content. The diversity of this FC 711 germplasm provides the potential for breeders to develop productive resistant hybrids with currently used monogerm male sterile parents.

RUPPEL, E. G., R. BAKER, G. E. HARMAN, J. P. HUBBARD, R. J. HECKER and I. CHET. Field tests of **Trichoderma harzianum** as a biocontrol agent of seedling disease in several crops and rhizoctonia root rot of sugar beet. Crop Prot.

In field studies, mean stands across crops of snapbean, field corn, pea, soybean, and squash in New York were somewhat greater from seeds treated with conidia of Trichoderma harzianum applied in a Methocel slurry than from nontreated controls; however, stands were poorer than those from captan-treated seed. The biocontrol agent and captan had little effect on kidney bean and field corn since these crops are only slightly susceptible to seedling disease. In Colorado fields heavily infested with Rhizoctonia solani, stands of sugar beet from T. harzianum-treated seeds (Pelgel slurry) tended to be greater than those from nontreated seeds and equal to those from maneb-treated seeds, but differences were not significant. In both Colorado and New York, seedling disease probably was caused by Pythium spp. A combined analysis of variance of treatments across 2 yr showed that a preplant incorporated in-row application of T. harzianum in a wheat bran carrier or a maneb seed treatment slightly, but significantly, reduced rhizoctonia root rot severity in sugar beet as compared with the nontreated control. Seed treatments with T. harzianum had little or no effect. In plots where the agent was applied to the soil, numbers of Trichoderma propagules increased 600-fold by harvest; where maneb seed treatment was used, they increased only five-fold. Densities of the agent remained the same or decreased in plots where Trichoderma was used as a seed treatment.

RUPPEL, E. G. and R. J. HECKER. 1983. Efficacy of sulfur for controlling rhizoctonia root rot in sugarbeet. Plant Dis. 67:156-158

Soil application of wettable sulfur and two flowable sulfurs was tested in the greenhouse for the control of seedling damping-off of sugarbeet caused by Rhizoctonia solani. Wettable sulfur did not control the disease. The flowables increased seedling survival over that of the control, but only in nonautoclaved soil, which indicated that the effect of sulfur may have been on some other biotic system with indirect effects on the pathogen. Another

biotic system was not identified; however, a biocontrol mechanism involving antagonism by Trichoderma spp. seemed unlikely. In a 1980 field test of the two flowables, preplant broadcast incorporated applications of both significantly reduced root rot intensity over nontreated controls. In 1981 no control was obtained with one flowable at three rates and two methods of application. If the action of sulfur is on some other biotic system as greenhouse tests indicated, conditions were not conducive for such a system to be operative in the 1981 field test.

RUPPEL, E. G., R. J. HECKER and E. E. SCHWEIZER. Rhizoctonia root rot of sugarbeet unaffected by herbicides. J. Am. Soc. Sugar Beet Technol. (In press.)

An increased incidence of sugarbeet (Beta vulgaris) root rot caused by Rhizoctonia solani somewhat paralleled increased herbicide use in the United States. To determine the existence of a possible disease-herbicide interaction, experiments were conducted on field sites heavily infested with the pathogen. In 1978, desmedipham and phenmedipham (each at 0.6 kg a.i./ha) were applied when sugarbeet cultivars FC 703 (resistant to R. solani) and Mono-Hy A1 (susceptible to R. solani) were in the four-leaf stage. In 1980, preplant broadcast applications of ethofumesate (2.2 kg a.i./ha) and diclofop methyl (1.7 kg a.i./ha), alone and in combination, were incorporated before planting Rhizoctonia-susceptible cultivar Mono-Hy D2. Trifluralin (0.6 kg a.i./ha), EPTC (3.4 kg a.i./ha), and metolachlor (2.2 kg a.i./ha) were applied broadcast and incorporated 1 week post thinning to cultivars FC 703, Mono-Hy D2, and HH 32 (intermediate resistance to R. solani) in 1981. Individual roots were harvested and rated for rot about 5 mo after planting; a disease index and % harvestable roots were calculated on a plot basis. No significant adverse or beneficial effects of the herbicides on the incidence or severity of root rot were detected in any test. Thus, there appears to be no evidence that herbicides used in this study played a role in the observed increase in rhizoctonia root rot of mature sugarbeet.

SMITH, G. A. and E. E. SCHWEIZER. 1982. Cultivar X herbicide interaction in sugarbeet (Beta vulgaris L.) Crop Sci. 23. (In press).

Eight commercial sugarbeet (Beta vulgaris L.) cultivars consisting of both diploid (2N = 2x = 18) and triploid (2N = 3x = 27) hybrids were studied for 2 years for their response to three herbicide regimes. The specific registered sugarbeet herbicides consisted of preplanting applications of (1) cycloate (3.4 kg/ha), (2) ethofumesate (2.2 kg/ha), and (3) a mixture of ethofumesate (2.2 kg/ha) + diclofop (1.7 kg/ha), each followed by a postemergence mixture of desmedipham and phenmedipham each applied at 0.6 kg/ha. A fourth treatment regime was that of no herbicide application. The six characters examined were 45-day plant dry weight, harvest root weight, foliar suppression, stand count, sucrose, and purity.

Differential herbicide and cultivar response was evidenced by significant year by herbicide, year by cultivar, and herbicide by cultivar interactions for several of the six characters analyzed. Although a significant second order interaction was detected for foliar suppression, none of the yield components (root weight, sucrose, purity) exhibited significant second order interactions.

Certain cultivars were suppressed significantly less than others at 45 days and recovered the most by harvest time. Under favorable soil

moisture and temperature conditions, the eight commercial cultivars showed reductions in total 45-day plant weight of 39 to 55% of their nontreated equivalent controls. In both years, early season suppression was mostly, but not entirely, overcome; by harvest, reductions averaged about 5%.

Papers Which Have Been Published Since the Previous Sugarbeet Research Report

HECKER, R. J. and E. G. RUPPEL. 1982. Registration of FC 702/6 sugarbeet germplasm. Crop Sci. 22:454.

HECKER, R. J. and E. G. RUPPEL. 1982. Registration of FC 703/4 sugarbeet germplasm. Crop Sci. 22:1275-1276.

MARTIN, S. S. 1982. Alternative aluminum clarification procedure. In McGinnies, R. A. (Ed.), Beet Sugar Technology, 3rd Ed., pp. 68-69. BSDF, Ft. Collins, CO.

MARTIN, S. S. 1983. Sugarbeet. Chapter 13, pp. 423-443 in Teare, I. D., and Peet, M. M. (Eds.), Crop-Water Relations. Wiley, N.Y.

SCHNEIDER, C. L., E. G. RUPPEL, R. J. HECKER and G. J. HOGABOAM. 1982. Effect of soil deposition in crowns on development of rhizoctonia root rot in sugar beet. Plant Dis. 66:408-410.

SMITH, G. A., E. E. SCHWEIZER, and S. S. MARTIN. 1982. Differential response of sugarbeet populations to herbicides. Crop Sci. 22:81-84.

SMITH, G. A. 1982. Herbicide resistant crops may be possible. Irrigation Age 4:31.

SMITH, G. A. 1982. Bright future seen for herbicide-resistant crops. Crops and Soil Magazine 35:8.

RAPID SELECTION AND REGENERATION OF ELITE SUGARBEET GENOTYPES (BSDF PROJECT 75)

Screening and Regeneration of Elite Sugarbeet Genotypes via Tissue Culture Techniques.--G. A. Smith and H. S. Moser.

In the first year of this BSDF-supported project significant progress was achieved. We can now routinely initiate shoot cultures from seedlings or floral stalk axillary buds.

The project basically has two objectives:

(1) To investigate and develop tissue culture techniques for proliferation of elite sugarbeet genotypes.

(2) To study and develop *in vitro* screening techniques effective in identification of herbicide tolerant genotypes.

Results to Date: Several genotypes highly tolerant to herbicides have been isolated from LSR heterogeneous populations. These genotypes were selected in media containing Nortron equivalent to four times the recommended field rate (i.e. 4X the active ingredient). Meristematic tissue was successfully proliferated, and rooted clonal ramets were obtained. These clonal families will be induced to flower, and seed increases and combining ability tests for Nortron tolerance will be initiated. Progeny from clonal seed will be evaluated in the greenhouse for herbicide tolerance prior to any field testing.

Representative Problem Areas: Our current research includes development of media for tolerance screening to Nortron and RoNeet which are both commonly used preemergence herbicides. Several postemergence herbicides will soon be added to the research project. Areas which require significant attention at present include: 1) The interaction of light and hormone concentration in rooting and shooting media: 2) Identification of screening criteria for each specific herbicide. The mode of action of each herbicide is somewhat different and the phenotypic effect is also different. In vitro concentrations of each herbicide must be studied to determine what level gives the "selectable" phenotypic result: 3) Rapidity of rooting of ramets. There appears to be considerable genetic variation among clonal families for rapidity of root initiation on either Naphthaleneacetic Acid or Indole-3-Butyric Acid: 4) Self-sterility, when present, in cloned genotypes will need to be dealt with in order to achieve seed increases. We have considered methods of dealing with this potentiality and will discuss this in a future report: 5) Chromosome stability. As has been reported for other species, we have found a low incidence of instability in tissue cultured material. Spontaneous tetraploidization during tissue culture has been detected: 6) Combining ability for the trait selected following several generations of seed increase after cloning. The question of comparative performance between successive generations following cloning must be addressed.

RHIZOCTONIA ROOT ROT RESISTANCE AND RESISTANCE BREEDING (BSDF Project 20B)

1982 Rhizoctonia Field Research.--R. J. Hecker and E. G. Ruppel

In 1982, the disease research projects funded by the BSDF were moved to the Colorado State University South Farm. The previous site of the disease research had been leased by the BSDF for 7 years and had been a good site, but the land was converted to another use. We are pleased to be involved in this new three-way cooperation among the BSDF, Colorado State University, and ARS, and hope that this cooperation will continue as long as there is need for disease resistance research in the field.

All 1982 rhizoctonia root rot experiments were conducted on an area of the farm that had been planted to corn for the past 3 years. There was a serious weed problem in the area, but it did not interfere with the accuracy of the disease assessments. Further, soil moisture in the seed bed was poor, resulting in some reduced stands; however, experience has shown that plant population density essentially has no effect on root rot intensity in our inoculated experiments.

Single-row plots, 6.1 (20 ft) long, and 56 cm (22 in) apart were planted May 18 and 19, thinned to about 25 cm (10 in) between plants around June 21, and inoculated July 21. Dry, ground barley-grain inoculum of *R. solani* (R-9) was broadcast in a band over each row with a tractor-mounted four-row granule applicator, except for the experiment on inoculation methods which is described in a subsequent section. The inoculum rate was 1.9 g/m of row in a split application (opposite direction of travel for each application). Intermittent overhead irrigation was used to moisten and activate the inoculum.

Roots in all experiments were lifted and individually rated for severity of rot between September 8 and 21. Disease index (DI) ratings were based on a scale of 0 to 7 (0 = no evidence of rot; 7 = plant dead and extensively decomposed). The percentage of healthy roots were those with index ratings of 0 and 1, those roots having no or only small arrested lesions. The percentage of roots in classes 0 through 3 also was used as a variable; these roots were sufficiently sound to be recovered in a commerical harvest, but did not include rotted roots rated greater than 3, even though they may have been sufficiently large and firm to have been recovered in the harvest.

The epiphytotic of root rot in our 1982 nursery was less severe than in past years due to a hail-delayed inoculation and excessive rainfall throughout the season. Nevertheless, we feel the epiphytotic was adequate for our root rot assessments.

The succeeding reports in this section on BSDF Project 20 describe individual experiments in our 1982 research on rhizoctonia root rot in sugarbeet.

Evaluation of Contributed Lines.--E. G. Ruppel and R. J. Hecker.

Separate randomized complete block designs with five replications were used to evaluate a total of 59 lines from American Crystal, Great Western,

Holly, and Hilleshog companies. In each test, Rhizoctonia-resistant line FC 703 and highly susceptible line FC 901 were included as controls. Results of each contributor's test were statistically analyzed and sent to company breeders; thus, they will not be reproduced here. The mean disease indexes for FC 703 and FC 901 across tests were 1.8 and 4.6, respectively. The % healthy means were 66 and 20%, whereas % roots in classes 0 through 3 (formerly, % harvestable) means were 89 and 39%, respectively.

Evaluation of Rhizoctonia Inoculation Methods.--E. G. Ruppel and R. J. Hecker.

The continued increase in levels of resistance to *Rhizoctonia solani* in breeding lines and hybrids evaluated in our field nursery may warrant changes in inoculation methods that would provide a greater selection pressure toward resistance. Thus, we compared 0.5, 1.5, and 4.0 g inoculum per 20-ft plot applied with the seed at planting (May 19) with 12 and 24 g inoculum per 20-ft plot applied topically at 63 days postplanting (30 days postthinning). A foliar rosette application (about 0.3 g inoculum/plant) and noninoculated plots served as controls. Two root rot resistant breeding lines (FC 703 and FC 707) were used in a 2 x 5 factorial design with six replications. Prethinning stand counts of the treatments where inoculum was applied with the seed (as % of noninoculated stands), and root rot data across lines (disease index, % healthy, and % roots in classes 0 through 3) are presented in Table 1.

Table 1. Seedling stands and root rot severity at harvest across two sugarbeet breeding lines in a comparison of inoculation methods with *Rhizoctonia solani* in the field

Inoculum application[1]	Rate[2] (g)	Stand[3] (%)	Root rot severity[4] DI	% H	% 0-3
With seed	0.5	92	1.3	88	96
	1.5	62	1.7	73	87*
	4.0	26	2.6*	49*	70*
Topical	12.0	--	2.1*	50*	84*
	24.0	--	3.3*	30*	57*
Foliar rosette	0.3	--	1.7	73*	92
Noninoculated control	--	--	0.9	95	99

[1]Applications with the seed were performed at planting; topical applications were made with a granule applicator 63 days after planting, along with the foliar rosette application.

[2]Rate of application with seed and topical applications are per 20-ft plot; the foliar rosette application is on a per plant basis.

[3]Prethinned stand counts are based on a percentage of appropriate noninoculated control stands.

[4]Disease serverity data taken at harvest in September: DI (disease index) on a scale of 0 to 7, with 0 = no rot and 7 = dead; % H = % healthy, calculated by combining disease classes 0 and 1; % 0-3 = calculated by combining classes 0 through 3 (formerly, % harvestable). * = significantly different from the control as determined by an LSD at $P = 0.05$.

Stand reduction was directly proportional to the amount of inoculum applied with the seed; however, except for the highest rate (4.0 g), the DIs and % healthy values for remaining roots at harvest were not significantly different from the noninoculated control. Since resistance to R. solani usually is not expressed in the seedling stage, low rates of inoculum applied with the seed apparently provide little selection pressure for rot resistance of mature roots.

Topical inoculum application with a granule applicator at either 12 or 24 g/20-ft plot provided moderate disease severity in the resistant lines, and the ease of application precludes the use of other inoculation methods. Future inoculations, however, probably will be done at the 24-g rate, which is double the rate used previously. It is not clear why the foliar rosette technique, which formerly induced severe epiphytotics, failed to induce DIs significantly different from the noninoculated control.

Line FC 707 was significantly better than FC 703 in DI and % healthy roots, but not in % roots in classes 0 through 3 (data not presented). There was no significant line x treatment interaction for either DI, % healthy, or roots in classes 0 through 3.

Evaluation of Germplasms in the Development of Resistance to Root Rotting Strains of R. solani--R. J. Hecker and E. G. Ruppel

Sugarbeet crop losses continue to occur due to rhizoctonia root rot. Of course, both growers and processors would like to eliminate this source of crop loss. The industry, through the BSDF, works toward the reduction of this loss through participation and support of programs designed to develop germplasm with resistance to this rot-causing fungus. Even though rhizoctonia root rot occurs in Japan, Uruguay, and Argentina, and has been reported in Iran, India, Pakistan, and Turkey, extensive research is only being done in the United States. Although rhizoctonia root rot caused by AG-2 strains of Rhizoctonia solani has not been reported to occur in sugarbeet in Europe, there does not appear to be any logical reason why the disease should not be a problem there, especially since AG-2 strains of the fungus are present. Hence, it is appropriate that there should be worldwide interest, concern, and support for the development of resistant germplasm.

Foliar and damping-off AG-4 strains of R. solani are apparently ubiquitous throughout the world; AG-2 strains also can cause seedling damping-off. However, losses due to seedling damping-off usually can be controlled with fungicide seed treatments in those crop areas where soil temperatures are relatively warm at planting time. Damping-off due to AG-2 and AG-4 usually is not a serious problem in areas where the soil temperatures are relatively low at planting time.

Due to the relatively low risk of serious crop loss due to rhizoctonia root rot, the incorporation of resistance into highly productive hybrid varieties is of relatively low priority to beet breeders. At the same time, growers are understandably reluctant to plant a variety that has some resistance, but which may sacrifice some yield in total absence of the disease.

It can be noted in Tables 1 and 2 in this section, that the most resistant germplasms had 60 to 70% healthy roots in our inoculated nursery where every plant was exposed to the pathogen at a relatively vunerable stage. If this level of resistance could be transferred completely into commerical hybrids, the incidence and loss due to rhizoctonia root rot under normal growing conditions conceivably would be reduced significantly. To accomplish this, breeders must incorporate high levels of resistance in both the male sterile and pollinator parents used to make the hybrid varieties. Despite the relatively low priority of Rhizoctonia-resistant varieties, breeders have nontheless made some effort and progress in the development of partially resistant hybrid varieties such as entries 454, 455, and 456 in Table 3. These hybrids with intermediate resistance undoubtedly will suffer less root rot loss in the field than susceptible hybrids.

In past research, we have demonstrated a dosage affect on resistance due to ploidy level. This means that breeders could enhance their levels of resistance in hybrids that involve only one resistant parent by converting that resistant parent to the tetraploid condition.

One resistant multigerm germplasm, FC 711, was released to BSDF members in 1982. FC 711 was not as resistant in the 1982 test (Table 1) relative to the check as it had been during its development. However, it was not significantly

different than the resistant check FC 703. This FC 711 germplasm is of Japanese origin, and is quite different than most other germplasms in the project. Due to genetic diversity, it may have a higher frequency of high combining ability in hybrids with U.S. and other male sterile parents.

The most resistant multigerm breeding lines in our 1982 inoculated nursery are shown in Table 1. Many of these breeding lines already have been released; others are candidates for release in the future.

Monogerm resistant lines (or segregating for monogerm) are shown in Table 2. Although a few of these lines are attractive from a resistance standpoint, they are not very far advanced with respect to type O, CMS, high-combining ability, and other necessary characteristics.

Shown in Table 3 are the rhizoctonia resistance ratings for various germplasms for potentially new sources of resistance. The three fodder beet entries (460, 461, and 462), have shown a significant amount of resistance in 1982 and 1981. Further research will be necessary to determine whether this is genetic resistance or infection avoidance due to the aerial growth habit of these particular fodder beets.

We are in the final process of the colchicine conversion of FC 708 CMS and FC 708 to autotetraploids (4x); seed will be released after the 1983 resistance evaluation.

In an effort to get a preliminary combining ability assessment of germplasms in our resistance development project, we have been generating experimental hybrids between our resistant lines and a set of monogerm, male sterile testers. After a disease-free test of productivity, reported in a subsequent section of this report, the most productive of these hybrids were then tested for resistance (see a subsequent section of this report). The most promising parental germplasms ultimately will be released.

Table 1. Rhizoctonia resistant multigerm breeding lines; disease index (DI), % healthy roots, and % rated 0 to 3 (Exp. 1R, 82).

Entry	Breeding line	DI	% healthy roots	% rated 0 to 3
377	FC 710	1.5	65	99
369	FC 707/2	1.6	65	94
387	FC 705/2	1.6	61	93
371	FC 705/1	1.7	54	94
375	Advanced FC 705	1.7	57	90
376	FC 709	1.7	63	95
388	FC 705	1.7	57	94
368	FC 707/1	1.8	61	92
374	FC 702/7	1.8	49	93
383	FC 703/2	1.8	65	89
373	FC 702/6	1.8	57	89
390	FC 707	1.8	62	89
449	Rh resist. inbred	2.0	38	96
439	Syn of resist. S_2	2.0	57	92
429	Resist. sels. from (Rh. lines X FC 704)	2.0	41	95
384	FC 703/3	2.0	48	98
392	FC 706	2.0	46	90
385	FC 703/5	2.0	42	88
389	FC 701/6	2.0	56	90
370	Advanced FC 706	2.1	56	86
431	3 cy Rh sel. from EL 42	2.2	33	86
393	FC 711	2.6	30	78
382	FC 703; resistant check	2.0	53	86
440	FC 901; susceptible check	5.5	0	17
	LSD(.05)	0.7	11	11

Table 2. Rhizoctonia resistance evaluation of monogerm breeding lines: disease index (DI), % healthy roots and % rated 0 to 3, (Ex. 1R, 82).

Entry	Description	DI	% healthy roots	% rated 0 to 3
430	Syn 2 from SP 5831-0	1.6	68	96
450	Resist. inbred	1.7	46	99
438	Syn of resist. S_2's and S_3's	2.2	41	82
418	Mono. sel. from FC 702/5 X FC 708, F_2	2.4	31	85
417	Mono. sel. from FC 705 X FC 708, F_2	2.4	28	81
402	FC 708 CMS	2.5	23	79
401	FC 708	2.6	24	80
411	FC 607 CMS X FC 708, BCP_2	2.7	33	69
433	Mono. sel. from Polish 4/73 X FC 709, F_2	3.2	19	66
434	mm TO from USSR mm pool	4.3	9	35
408	EL 44 CMS	6.3	1	6
397	562 CMS X 546	6.4	1	4
382	FC 703; resistant check	2.0	53	86
440	FC 901; susceptible check	5.5	0	17
	LSD (.05)	0.7	11	11

Table 3. Rhizoctonia resistance evaulation of exotic and miscellaneous germplasms (Ex. 1R, 82).

Entry	Description	DI	% healthy roots	% rated 0 to 3
433	Polish 2*x* - 4/73, mm, high suc.	6.9	0	0
454	HH32	3.6	23	53
455	ACH 139	4.0	12	40
456	70 MSH 386	4.3	6	30
457	Tribel	5.1	1	21
458	Monohill	5.0	0	24
459	Zwaanpoly	4.9	4	33
460	Peramono; fodder beet	2.6	24	88
461	Goliat TPW; fodder beet	2.9	23	81
462	Monara; fodder beet	3.0	13	81
463	Peroba; fodder beet	4.2	4	53
382	FC 703; resistant check	2.0	53	86
440	FC 901; susceptible check	5.5	0	17
	LSD (.05)	0.7	11	11

Comparison of Methods to Select for Resistance to Rhizoctonia Solani.--R. J. Hecker and E. G. Ruppel

In previously reported research, we have demonstrated the quantatitive nature of resistance to root-rotting strains of Rhizoctonia solani. The narrow-sense heritablity (h^2) was about 0.25. Progress toward high levels of resistance to this pathogen has been very slow, as would be expected when dealing with a quantitative character having low heritability. In an attempt to more precisely identify resistant genotypes, we conducted three different selection studies, as follows: (1) greenhouse and field selection for root rot resistance, commencing in a population that was relatively resistant; (2) greenhouse selection for root rot resistance in a susceptible population; and (3) greenhouse selection for resistance to damping-off caused by root rotting strains of Rhizoctonia solani. The preliminary results of these three studies are being reported in this section.

Greenhouse and Field Selection for Root Rot Resistance in FC 703

In this study, FC 703 was the source population, which was one of the most resistant sources available when the study was commenced. To make the greenhouse selections, we used about 250, uniform, 3-mo-old individual plants which were inoculated by burying about 0.8 cc inoculum of a root-rotting strain of Rhizoctonia solani (R-9) 1 cm deep next to each tap root. After 4 weeks, the remaining plants were washed free of all soil, and the roots were examined and selected for the absence of any apparent Rhizoctonia infection. In each of the selection cycles, we had from 12 to 32 disease-free roots which were transplanted, photothermally induced, and interpollinated. The succeeding selection cycie was made from a composite of equal seed quantity from the previous parental plants.

The field selections and reproductions were made with about the same number of plants. Field inoculations were made with our standard procedure described in an earlier section of this report, and selections were made about September 15 when each root was lifted and examined. After three cycles of selection in both the greenhouse and the field, the resulting populations were assessed for resistance to Rhizoctonia in the field in 1982; however, there was insufficient seed remaining in the second-cycle greenhouse selection to include it in the 1982 evaluation.

Results of our field evaluations are shown in the top section of Table 1. We apparently made some genetic progress towards resistance, since the population from the third cycle of greenhouse selection was significantly more resistant than the source population as indicated by the disease index, percent healthy roots, and percentage of roots rated 0 to 3. The comparable field selections show almost identical progress toward resistance.

Greenhouse Selection for Root Rot Resistance in SP6322-0:

Selections made in the greenhouse for root rot resistance in a susceptible source (SP6322-0) failed to show any genetic gain for resistance after two cycles of selection (Table 1). The methods used in this case were the same as those used when selecting in the resistant population (FC 703). Further selection in SP6322-0 was abandoned.

Greenhouse Selection for Resistance to Damping-Off:

Since the root rotting strains of *Rhizoctonia solani* also caused damping-off of seedlings, we tested the effect of selecting for apparent damping-off resistance on actual root rot resistance. At the bottom of Table 3 is the result of six cycles of selection for damping-off resistance. These results indicate that, in the selection process, we actually lost some root rot resistance as indicated by the increasing disease index (DI) from the source population to the 6th cycle of selection. Although this DI difference was not great enough to be significant, there was significance in the case of percent healthy roots (24% in the 6th cycle selection versus 49% in the source population). The source population in this case was a mixture of our most resistant lines when the study was initiated. Although observations by ourselves and others indicated that our root rot resistant germplasms are more resistant to damping-off by root-rotting strains of the pathogen (AG-2) this study indicated that selecting specifically for seedling damping-off resistance somehow isolated genotypes that were more susceptible to rot of more mature roots. Hence, it would appear that our attempt to find a more rapid, precise, and economical method of selection for root rot was not successful.

In conclusion, selection for rot resistance in more mature roots was equally effective in the greenhouse and field when started with a relatively resistant population. In the case of the susceptible population, we could not show any progress in two cycles of selection, but this is not surprising since our experience in making field selections in susceptible sources is that 3 or 4 cycles of selection are usually necessary before significant progress toward resistance can be recognized. Since greenhouse selection for rot resistance as done in this study requires much greenhouse space, time, and effort, and limits the number of plants, we consider it more practical and economical to make root rot inoculations, assessments, and selections in an inoculated field nursery. Also, based on results of this study, we cannot recommend selection of resistance to damping-off by root rot strains of the pathogen as a means of selecting for root rot resistance. Our methods of field inoculation and selection remain the best available; however, we plan to continue experiments designed to discover more precise means of identfying and isolating genotypes that are more resistant to root rot by AG-2 strains of *Rhizoctonia solani*.

Table 1. Rhizoctonia resistance evaluation of various lines selected in various ways (Ex. 3R, 82).

Entry	Description	DI	% healthy roots	Roots (%) rated 0 to 3
Greenhouse and field selection for root rot resistance				
226	Source (FC 703)	2.6a [1/]	39a	74a
227	1st cycle GH selection	2.5a	45a	74a
225	3rd cycle GH selection	1.9b	63b	90b
230	1st cycle field selection	2.6a	52a	74a
235	2nd cycle field selection	2.1a	58b	80a
233	3rd cycle field selection	1.9b	59b	89b
Greenhouse selection for root rot resistance in susceptible source				
238	Source (SP6322-0)	4.7a	6a	31a
237	1st cycle GH selection	4.3a	14a	37a
239	2nd cycle GH selection	4.4a	7a	29a
Greenhouse selection for damping-off resistance				
219	Source (mix of resist lines)	2.1a	49a	80a
224	1st cycle selection	2.4a	45a	77a
222	3rd cycle selection	2.3a	44a	74a
221	4th cycle selection	2.6a	42a	72a
220	6th cycle selection	2.7a	24b	69a

1/ Means followed by the same letter within the same column within the same group are not significantly different ($P = .05$).

Combining Ability Test for Sucrose Yield of Rhizoctonia Resistant Experimental Hybrids--R. J. Hecker and G. A. Smith

The one hundred experimental hybrids in this combining ability test were grown under disease free conditions at the CSU Agronomy Research Center using single row plots in a triple lattice design with six replications. A set of monogerm cytoplasmic male sterile lines was crossed with 10 Rhizoctonia resistant pollinators. The average performance of the set of hybrids with a common pollinator parent is shown in Table 1. These data provide some information on the relative general combining ability of these 10 pollinators. The most promising pollinator from the standpoint of general combining ability for sucrose production appears to be FC 705/1. FC 709, FC 705, and FC 702/7 also had relatively good general combining ability for sucrose yield. Root rot resistance of these four pollinators was similar as determined from a per se resistance evaluation in the 1982 inoculated nursery. FC 710 which is a new germplasm having been derived from miscellaneous *Beta vulgaris* and *B. maritima* sources was not outstanding in it's combining ability but it did have the lowest disease index among all these pollinators. Some of the other resistant pollinators in Table 1, although not showing outstanding general combining ability do have some good specific hybrid combinations as indicated in Table 2.

Table 2 shows the performance of the best individual hybrids in this test, hence, ones that have relatively good specific combining ability. All hybrids listed in Table 2 are not significantly different for gross sucrose yield from the check, Mono Hy D2. These best hybrids detected in this combining ability test will be included in the advance yield test in 1983.

The CMS parents in these hybrids are all single crosses among USDA developed germplasms. The relative good general combining ability of some of these pollinators gives promise that some highly productive specific hybridizations might be made with high combining CMS's being used by commercial breeders. Those pollinators in Table 1 which have not yet been released will be released as soon as their level of resistance is considered adequate for them to be potentially useful as pollinators. However, specific pollinators could be released in response to specific requests.

The sucrose productivity in this test was very low, primarily due to the exceedingly low sucrose content. However, the results of the test can be considered relatively reliable, because hybrid by fertility level interations are usually not so large that they distort the general performance of the hybrid.

Table 1. Average performance in a disease-free test (Ex. 1, 82) of hybrids from a set of CMS testers crossed with the specified pollinators; disease indices (DI) are for the pollinators per se in an inoculated field test (Ex. 1R, 82).

Resistant pollinator	Gross sucrose (T/A)	Root yield (T/A)	Sucrose (%)	DI
FC 705/1	2.71	23.5	11.6	1.7
FC 709	2.64	22.9	11.5	1.7
FC 705	2.62	20.1	11.2	1.8
FC 702/7	2.61	21.2	12.3	1.8
FC 705/2	2.46	21.7	11.3	1.7
FC 707/1	2.45	22.0	11.0	1.8
FC 710	2.44	21.2	11.6	1.5
FC 707/2	2.42	22.1	10.9	1.6
FC 702/6	2.40	20.2	11.8	1.8
3rd cy sel from EL 42	2.37	21.9	10.9	2.2

Table 2. Superior experimental hybrids in the 1982 disease-free combining ability test (Ex. 1, 82) of hybrids involving Rhizoctonia resistant pollinators.

Entry No.	Hybrid	Gross sucrose (T/A)	Root yield (T/A)	Sucrose (%)
895	(FC 502/2 CMS X 662119sl) X FC 705/1	3.34	28.4	11.8
838	(622112sl CMS X 662119sl) X FC 705/1	3.02	26.4	11.5
801	(EL 44 CMS X FC 708) X FC 705/1	3.01	25.2	11.9
811	(FC 502/2 CMS X 662119sl) X FC 709	2.91	25.9	11.2
874	(EL 44 CMS X FC 708) X FC 709	2.90	24.0	12.1
812	FC 606 CMS X FC 705/1	2.88	25.0	11.5
896	(FC 502/2 CMS X 662119sl) X FX 702/6	2.87	23.8	12.0
810	(FC 502/2 CMS X 662119sl) X FC 710	2.86	23.4	12.2
894	(EL 44 CMS X FC 708) X FC 705	2.81	23.9	11.7
834	(SLC 129 CMS X mm TO fr. USSR) X FC 705/1	2.81	24.6	11.4
878	(FC 502/2 CMS X 662119sl) X FC 705	2.79	25.5	10.9
876	(622112sl CMS X 662119sl) X FC 705	2.79	25.7	10.9
846	(EL 44 CMS X FC 708) X FC 702/7	2.78	20.7	13.4
900	(FC 202/2 CMS X 662119sl) X FC 707/2	2.74	24.9	11.0
885	(EL 44 CMS X FC 708) X FC 702/6	2.73	21.7	12.5
860	(SLC 129 CMS X FC 708) X FC 705	2.69	23.5	11.5
887	(622119sl CMS X 662119sl) X FC 710	2.69	24.5	11.0
804	(EL 44 CMS X FC 708) X FX 707/1	2.67	23.5	11.3
	Mono Hy D2 (check)	3.03	25.3	12.0
	LSD (.05)	0.42	3.2	1.0

Performance of Experimental Hybrids Involving Rhizoctonia Resistant Pollinators--R. J. Hecker and G. A. Smith

One of the subprojects within Project 20 is the development of Rhizoctonia resistant germplasms. To be useful these germplasms must find a place in commerical breeding programs. To assess the utility of our resistant germplasms we use the multigerm resistant lines as pollinators on a set of male sterile testers. This is a means of making a combining ability assessment of the resistant pollinator germplasms. In this combining ability test each year, we identify those hybrids that display relatively good specific combining ability for sucrose production. These most promising hybrids are then evaluated for sucrose production and rhizoctonia resistance in the succeeding year. The yield tests are grown disease free at the CSU Agronomy Research Center, and the resistance assessment is made in our inoculated rhizoctonia nursery.

Table 1 in this section shows the results of this advanced testing of the most promising hybrids detected in the 1980 and 1981 combining ability tests. The first three hybrids have had 2 years of advanced testing and the succeeding 11 hybrids have been in the advanced test for only 1 year. The 1982 yield test was much more variable than the 1981 test and had a much lower average sucrose. In 1982, only the fourth hybrid yielded significantly more sucrose than the check, Mono Hy D2, all the others were not significantly different. The four hybrids involving the resistant line selected from the USSR multigerm materials all tended to have higher root yield but rather drastically lower sucrose content. This was obviously a characteristic of this particular male parent. All but one of the experimental hybrids had sigfnificantly more rhizoctonia resistance than the Mono-Hy D2 check, while eight were significantly more resistant than HH 32, a commerical hybrid with a modest amount of resistance. Under disease free commercial production conditions some of the experimental hybrids in this test would be expected to be equivalent to Mono Hy D2 in sucrose production. However, under stress of the disease many of them should be more productive than Mono Hy D2 due to the resistance that they exhibit. It is likely that various of the Rhizoctonia resistant pollinators in this test would combine quite well with some of the male steriles being used by commerical breeders, producing partially Rhizoctonia resistant hybrids which might consistently outperform Mono Hy D2 under disease free conditions and almost certainly outperform susceptible hybrids in fields with significant amounts of Rhizoctonia infestation. Some of the pollinators in Table 1 have been previously released to BSDF members. Any of the nonreleased pollinators would be released upon request of any BSDF member. Any BSDF members interested in testing any of these specific hybrids are welcome to any remanent seed that we have. The first five hybrids listed in Table 1 might have potential where rhizoctonia root rot is a serious problem.

Table 1. Experimental hybrids (susceptible CMS x resistant pollinator); disease index (DI) from inoculated field tests (Ex. 8R, 81 and 2R, 82) and yield from disease-free tests (Ex. 2, 81 and 2, 82).

Hybrid or check	DI			Recov. suc.(T/A)			Root yield (T/A)			Sucrose (%)		
	81	82	$\bar{x}$	81	82	$\bar{x}$	81	82	$\bar{x}$	81	82	$\bar{x}$
(SLC 129 CMS X EL 44) X FC 703/4	4.6	3.7	4.2	3.46	2.88	3.17	26.1	26.8	26.4	16.4	14.1	15.2
(SLC 129 CMS X French mm TO) X FC 703/4	4.4	3.7	4.0	3.62	2.30	2.96	27.0	22.9	25.0	16.6	13.6	15.1
(FC 604 CMS X Polish PI 372277) X FX 702/7	4.2	3.5	3.8	3.27	2.43	2.85	24.2	22.5	23.4	16.7	14.2	15.4
(662119s1 CMS X 562) X FC 701/6		3.1			3.15			33.4			13.0	
(662119s1 CMS X 562) X Resist. Pool		2.6			2.95			33.7			12.6	
(SLC 129 CMS X SLC 133) X FC 701/6		3.8			2.90			28.7			13.6	
(FC 505 CMS X 562) X FC 703/3		2.9			2.62			25.8			13.5	
FC 606 CMS X FC 706		3.5			2.56			26.0			13.4	
(562 CMS X 546) X Resist. USSR MM		3.6			2.53			30.8			11.9	
(FC 505 CMS X 562) X FC 701/6		2.4			2.46			27.2			12.8	
[(FC 504 CMS X FC 5042) X 662119s1] X FC 707		3.0			2.34			24.5			13.2	
(FC 506 CMS X 562) X Resist. USSR MM		2.9			2.28			27.7			11.8	
[(FC 504 CMS X FC 5042) X 662119s1] X Resist. USSR MM		3.0			2.21			27.9			11.6	
(662119s1 CMS X 562) X Resist. USSR MM		2.9			2.08			28.1			11.3	
HH 32; comm. resist. hyb.	4.8	4.1	4.4	3.47	2.28	2.88	26.1	25.5	25.8	16.4	12.5	14.4
Mono Hy D2; comm. hyb.	5.3	4.7	5.0	3.32	2.50	2.91	25.6	24.5	25.0	16.0	13.7	14.8
FC 703; resistant check	2.6	2.4	2.5									
FC 901; susceptible check	6.2	5.5	5.8									
LSD (.05)	0.8	1.0		0.27	0.56			2.0	4.5		0.5	1.3

CERCOSPORA/CURLY TOP RESISTANCE BREEDING AND RELATED RESEARCH (BSDF PROJECT 25)

1982 Cercospora Field Research--G. A. Smith and E. G. Ruppel

The 1982 Cercospora field research supported by BSDF project 25 was conducted at a new location on property owned by Colorado State University. The normal problems associated with establishing research plots at a new location were encountered. Slow recovery from hail damage delayed inoculations by 1 week, but ideal climatic conditions after inoculations permitted a moderately severe epiphytotic to develop peaking about August 30. Leaf spot evaluations were made August 30 and September 3. On August 30, the mean rating of the susceptible check across all company tests was 6.9, whereas the resistance check was 3.0. These values in 1981 for the same checks were 8.0 and 4.1, respectively.

Leaf Spot Evaluations of Sugarbeet Lines Submitted by BSDF-Member Companies.--E. G. Ruppel and G. A. Smith

Separate randomized complete block designs with two replications were used to evaluate a total of 195 breeding lines submitted by American Crystal, Betaseed, Bush Johnson, Great Western, Hilleshog, Holly, Mennesson, and Van der Have companies for resistance to *Cercospora beticola*. Internal checks included leaf spot resistant FC(504 x 502/2) x SP6322-0 and a highly susceptible synthetic. Two-row plots were 4 m long with 56 cm between rows. The nursery was planted on April 23; inoculations were made twice, on July 13 and 21. Company lines ranged from 2.3 to 7.5, compared with 2.8 to 8.5 in 1981. Results of the individual company tests were tabulated, statistically analyzed, and sent to the appropriate contributor.

Breeding for Resistance to Cercospora and Curly Top Virus 1982.--G. A. Smith and E. G. Ruppel

The cooperative effort of Dr. D. L. Mumford in the Curly Top evaluations is hereby acknowledged.

The leafspot epidemic in our 1982 nursery would be termed moderate in comparison to past years, but adequate for evaluations of breeding lines. The curly top epidemic at Logan was considered severe, possibly due to the early release of leafhoppers following thinning on June 21. U.S. 41 averaged 4.5 and U.S. 33 averaged 6.4.

The results from our breeding nursery tests for the 1982 nurseries are presented in Table 1. Only selected entries from the Ft. Collins breeding program are tested for curly top reaction at Logan. Fifty of the 143 entries evaluated for leaf spot resistance equaled or exceeded the resistance of the long term resistant check. Most of the Ft. Collins entries equaled or exceeded the curly top resistance of the resistant check at Logan. This is especially noteworthy because of the severity of the curly top epidemic.

The newly converted tetraploid form of FC 606 and FC 606 CMS, entries 1438 and 1439, displayed about the same leafspot resistance as its diploid form (entries 1440 and 1569). Those entries and the tetraploid version of FC 607 will be released following further seed increase and testing. Several entries exhibited high resistance to both cercospora and curly top.

Table 1. Mean leaf spot and curly top ratings of some breeding lines and other entries at Ft. Collins, CO, and Logan, UT, 1982.

ENTRY NO.	SEED NO.	DESCRIPTION	LEAF SPOT	CURLY TOP
1438	821034HO	FC 606 T.O. 4X	3.8	
1439	821034HO1	FC 606 CMS 4X	3.5	
1440	A78-44	FC 606 T.O	3.5	
1441	811001 HO5	(652016s1 CMS X 662119s1 T.O.) X FC 604 T.O. X FC708	4.0	
1442	811001 HO6	(FC 605 CMS X FC 502/3 T.O.) X FC708	2.8	
1443	811001 HO7	FC 605 CMS X FC708	2.3	
1444	811001 HO8	(652016s1 CMS X FC605) X FC708	3.0	
1445	811002 HO2	(FC605 CMS X FC502/2 T.O.) X FC708	3.8	
1446	811002 HO3	(652016s1 CMS X 662119s1 T.O.) X FC708	3.8	
1447	811002 HO4	(622112s1 CMS X 662119s1 T.O.) X FC708	4.0	
1448	811002 HO5	652016s1 CMS X FC708	3.0	
1449	811002 HO7	(1861CMS X FC606 T.O.) X FC708	4.8	
1450	811002 HO8	(1861CMS X 12166 T.O.) X FC708	5.5	
1451	811003 HO2	662119s1 CMS X FC607 T.O. mm LSR-CTR	3.5	3.5
1452	811004 HO2	FC607 CMS X SP74564-0 T.O. mm	2.8	
1453	811004 HO3	FC506 CMS X SP74564-0 T.O. mm	3.5	
1454	811004 HO4	FC606 CMS X SP74564-0 T.O. mm	3.5	
1455	811004 HO5	FC608 CMS X SP74564-0 T.O. mm	3.0	
1456	811006 HO	FC608 T.O.	3.8	
1457	811006 HO2	FC607 CMS X FC608 T.O.	3.5	3.0
1458	811006 HO3	FC506 CMS X FC608 T.O.	3.3	4.0
1459	811006 HO4	(FC603 CMS X FC605 T.O.) X FC608 T.O.	3.3	4.0
1460	811006 HO5	(1861 CMS X FC605 T.O.) X FC608 T.O.	3.5	3.5
1461	811006 HO6	(642027s1 CMS X 662119s1 T.O.) X FC605 X FC608 T.O.	3.3	2.5
1462	811006 HO7	(632028s1 CMS X FC605 T.O.) X FC608 T.O.	3.3	3.0
1463	811006 HO8	(FC605 CMS X 1861 T.O.) X FC608 T.O.	2.8	3.5
1464	811007 HO2	(652016s1 CMS X 662119s1 T.O.) X FC604 T.O. X FC608 T. O.	3.8	3.0
1465	811007 HO3	(FC605 CMS X FC502/3 T.O.) X FC608 T.O.	3.0	4.0
1466	811007 HO4	(FC605 CMS X 761036 HO mm) X FC608 T.O.	3.3	3.5
1467	811007 HO5	(652016s1 CMS X 662119s1 T.O.)X FC608 T.O.	3.8	3.5
1468	811007 HO6	(622112s1 CMS X 662119s1 T.O.)X FC608 T.O.	4.5	4.0
1469	811007 HO7	(622112s1 CMS X 1861 T.O.)X FC608 T.O.	4.5	2.5
1470	811008 H2	FC607 CMS X SP6322-0 MM	3.3	
1471	811008 H3	FC606 CMS X SP6322-0 MM	3.5	
1472	811008 H4	662119s1 CMS X SP6322-0 MM	3.3	
1473	811008 H5	FC608 CMS X SP6322-0 MM	3.3	
1474	811008 H6	FC(504 CMS X 502/2 T.O.) X SP6322-0 MM	3.0	
1475	811008 H7	(662119s1 CMS X FC605) X SP6322-0 MM	3.0	
1476	811008 H8	(FC603 CMS X 605) X SP6322-0 MM	3.5	
1477	811008 H9	(1861 CMS X FC605) X SP6322-0 MM	3.3	
1478	811008 H10	(642027s1 CMS X 662119s1 T.O.)X FC605 X SP6322-0 MM	3.5	
1479	811008 H11	(632028s1 CMS X FC605 T.O.) X SP6322-0 MM	2.8	
1480	811009 H	SP6322-0 MM	3.0	
1481	811009 H2	(FC605 CMS X 1861 T.O.) X SP6322-0 MM	3.8	

Table 1. Mean leaf spot and curly top ratings...-Continued

ENTRY NO.	SEED NO.	DESCRIPTION	LEAF SPOT	CURLY TOP
1482	811009 H3	(652016sl CMS X 662119sl T.O.) X FC604 T.O. X SP6322-0 MM	3.5	
1483	811009 H4	(FC605 CMS X FC502/3 T.O.) X SP6322-0 MM	3.0	
1484	811009 H5	(FC605 CMS X 761036 HO mm) X SP6322-0 MM	3.0	
1485	811009 H6	(652016sl CMS X 662119sl T.O.) X SP6322-0 MM	3.5	
1486	811009 H7	(662112sl CMS X 6622119sl T.O.) X SP6322-0 MM	3.3	
1487	811009 H8	(1861 CMS X FC606 T.O.) X SP6322-0 MM	3.5	
1488	811009 H9	(1861 CMS X 12166 T.O.) X SP6322-0 MM	3.75	
1489	811009 H10	(622112sl CMS X 1861 T.O.) X SP6322-0 MM	4.00	
1490	811010 H	761016H MM non-T.O.	4.00	
1491	811010 H2	FC607 CMS X 761016 H MM non-T.O.	3.50	
1492	811010 H3	FC606 CMS X 761016 H MM non-T.O.	3.00	
1493	811010 H4	FC 608 CMS X 761016 H MM non-T.O.	3.50	
1494	811010 H5	(622112sl CMS Z 1861 T.O.) X 761016 H MM non-T.O.	4.50	
1495	811011 HO	761036HO CTR LSR mm; 662110sl T.O.	3.75	
1496	811011 HO2	FC506 CMS X 761036HO, CTR, LSR, mm; 662110sl T.O.	3.00	
1497	811011 HO3	662119sl CMS X 761036 HO, CTR, LSR, mm; 662110sl T.O.	3.25	3.5
1498	811011 HO4	(662119sl CMS X FC605 T.O.)X761036HO, CTR, LSR, mm; 662110sl T.O.	3.00	2.5
1499	811011 HO5	FC(603CMS X 605 T.O.) X 761036HO CTR, LSR, mm; 662110sl T.O.	3.25	
1500	811011 HO6	(1861 CMS X FC 605 T.O.) X 7610-36HO, CTR, LSR, mm; 6621101sl	3.50	
1501	811011 HO7	(632028sl CMS X FC605 T.O.) X 761036HO, CTR, LSR, mm; 6621101sl	3.25	3.0
1502	811011 HO8	(FC605 CMS X 1861 T.O.) X 761036HO, CTR, LSR, mm; 6621101sl	4.00	
1503	811011 HO9	FC605 CMS X 761036HO, CTR, LSR, mm; 6621101sl	2.75	
1504	811012 HO2	(652016sl CMS X FC605) X 761036HO, CTR, LSR, mm; 6621101sl	3.25	4.0
1505	811012 HO3	FC(605 CMS X 502/2 T.O.) X 761036HO, CTR, LSR, mm; 6621101sl	3.00	
1506	811012 HO4	(652016sl CMS X 662119sl T.O.) X 761036, CTR, LSR, mm; 6621101sl	2.50	
1507	811012 HO5	(622112sl CMS X 662119sl T.O.) X 761036HO, CTR, LSR, mm; 6621101sl	3.25	2.5
1508	811012 HO6	FC603 CMS X 761036HO, CTR, LSR, mm; 6621101sl	3.75	
1509	811012 HO7	FC502/3 CMS X 761036HO, CTR, LSR, mm; 6621101sl	2.75	
1510	811012 HO8	(1861 CMS X FC606 T.O.) X 761036HO, CTR, LSR, mm; 6621101sl	3.50	
1511	811012 HO9	(1861 CMS X 12166T.O.) X 761036HO, CTR, LSR, mm; 662110sl T.O.	4.00	2.5

Table 1. Mean leaf spot and curly top ratings...--Continued

ENTRY NO.	SEED NO.	DESCRIPTION	LEAF SPOT	CURLY TOP
1512	811012 H10	(622112sl CMS X 1861 T.O.) X 761036HO, CTR, LSR, mm; 6621101sl T.O.	3.75	3.0
1513	811014 H02	(FC605 CMS X 761036 HO mm) X FC506 T.O.	3.75	3.5
1514	811014 H03	(622112sl CMS X 662119sl T.O.)X FC506 T.O.	4.00	5.0
1515	811015 H02	662119sl CMS X FC605 T.O.	3.50	3.0
1516	811015 H03	(622112sl CMS X 662119sl T.O.)X FC605 T.O.	3.25	3.0
1517	811018 H02	662119sl CMS X 1861 T.O.	4.00	
1518	811018 H03	FC608 CMS X 1861 T.O.	5.00	
1519	811018 H04	FC605 CMS X 1861 T.O.	4.00	2.5
1520	811019 HO	FC607 T.O. Reselected	3.00	
1521	811019 HO1	FC607 CMS X FC607 T.O.	3.50	
1522	811020 HO	FC606 T.O. Reselected	2.50	
1523	811020 HO1	FC606 CMS X FC606 T.O.	3.00	
1524	811025 H	Spanish L.S. "Tolerant" line 4X 740002	4.00	
1525	811025 H2	FC606 CMS X Spanish LS "Tolerant line" 4X 740002	3.00	
1526	811025 H3	(FC605 CMS X 1861 T.O.) X Spanish LS "Tolerant line" 4X 740002	3.25	
1527	811026 H2	FC606 CMS X Spanish LS "Tolerant" line 4X 740008	3.0	
1528	811026 H3	(FC605 CMS X 1861 T.O.) X Spanish LS "Tolerant" line 4X 740008	3.5	
1529	811027 H2	FC606 CMS X Spanish LS "Tolerant" line 4X 740010	3.5	
1530	811027 H3	(FC605 CMS X 1861 T.O.) X Spanish LS "Tolerant" line 4X 470010	3.5	
1531	811028 H2	FC606 CMS X Spanish LS "Tolerant" line 4X 74004	3.0	
1532	811028 H3	(632028sl CMS X FC605 T.O.) X Spanish LS 'Tolerant" line 4X 740004	3.0	
1533	811018 H4	(FC 605 CMS X 1861 T.O.) X Spanish LS "Tolerant" line 4X 740004	2.8	
1534	811029 H	Spanish LSR, 645, 4X 740480	3.5	
1535	811029 H2	(632028sl CMS X FC605 T.O.) X Spanish LSR, 645, 4X 740480	3.3	
1536	811029 H3	(FC605 CMS X 1861 T.O.)X Spanish LSR, 645, 4X, 740480	3.3	
1537	811030 H	Aula Dei 646 (4X) LSR	4.8	
1538	811030 H2	(632028sl CMS X FC 605 T.O.) Aula Dei 646(4X) LSR	4.0	
1539	811030 H3	(FC605 CMS X 1861 T.O.) X Aula Dei 646 (4X) LSR	4.3	
1540	811031 H	Aula Dei 645 (4X) LSR	2.8	
1541	811031 H2	FC606 CMS X Aula Dei 645 (4X) LSR	3.0	
1542	811031 H3	(632028sl CMS X FC605 T.O.) X Aula Dei 645 (4X) LSR	3.3	
1543	791013 HO3	FC502/3 CMS X FC605 T.O. mm	3.3	
1544	791013 HO4	662119sl CMS X FC605 T.O. mm	3.3	3.0
1545	791013 HO5	FC603 CMS X FC605 T.O. mm	3.3	3.5
1546	791013 HO6	642027sl CMS X FC605 T.O. mm	3.3	3.5
1547	791013 HO8	(642027sl CMS X 662119sl T.O.) X FC605 T.O. mm	3.0	

Table 1. Mean leaf spot and curly top ratings...--Continued

ENTRY NO.	SEED NO.	DESCRIPTION	LEAF SPOT	CURLY TOP
1548	791013 H09	632028sl CMS X FC605 T.O. mm	3.3	
1549	791015 H02	FC605 CMS X FC502/2 T.O.	2.8	
1550	791015 H04	(652016sl CMS X FC605) X FC502/2 T.O.	3.0	
1551	791016 H03	FC606 CMS X FC502/3 T.O.	3.0	
1552	791016 H04	(652016sl CMS X 662119sl T.O.) X FC502/3 T.O.	3.0	
1553	791017 H06	FC(504 X 502/2)CMS X FC605 T.O. X 662119sl T.O.	3.3	3.5
1554	791019 H03	FC605 CMS X 661153HO; 642027sl = FC603 T.O.	3.8	3.5
1555	791019 H04	FC502/2 CMS X 661153HO; 642027sl = FC603 T.O.	2.5	
1556	791019 H05	FC606 CMS X 661153HO; 642027sl = FC603 T.O.	3.5	3.5
1557	791019 H06	(652016sl CMS X FC605) X 661153HO; 642027sl = FC603 T.O.	2.8	
1558	791024 H02	FC502/2 CMS X 622027sl, 642010sl, T.O.	3.0	
1559	791025 H04	FC(504 X 502/2)CMS X FC605 X 622112sl, 642063 T.O.	2.8	4.5
1560	791026 H02	FC606 CMS X SP550	2.5	
1561	791056 H9	FC607 CMS X SYN of GH rh. sel from FC 703	3.3	
1562	791122 H6	FC(504 X 502/2) CMS X FC605 X 5th cy. low amino N sel at high N fertility	3.3	
1563	761039 H02	FC605 CMS X FC(504 X 502/2) X SP6322-0	3.3	
1564	761036 H05	FC605 CMS X 731021HO, T.O. mm res to CT. fr. 701162HO	2.8	3.5
1565	751102 H05	FC506 CMS X FC605 T.O.	3.0	
1566	771077	US201	3.5	
1567	781067 H2	FC(504 CMS X 502/2) X FC605 X M-line syn fr FC 702/5	3.3	
1568	A79-68	FC607 CMS	2.8	
1569	A78-45	FC606 CMS	3.3	4.0
1570	A81-62	Mono Hy E4	3.3	
1571	801093 H04	642027sl CMS X FC608 T.O.	3.5	
1572	801093 H07	FC(504 CMS X 502/2) X FC 608 T.O.	3.0	
1573	801095 H04	FC(504 CMS X 502/2) X FC606 T.O. mm LSR-CTR	3.0	
1574	801096 H02	FC608 CMS X 761036HO mm from 662110sl, LSR-CTR	2.8	
1575	801096 H06	(642027sl CMS X 662119sl T.O.) X 761036 HO mm fr 662110sl LSR-CTR	3.0	
1576	801096 H07	FC605 CMS X 761036 HO mm fr. 662110sl, LSR-CTR	3.0	
1577	801096 H08	FC506 CMS X 761036HO mm fr. 662110sl, LSR-CTR	2.5	
1578	801123 HO	FC607 T.O. Reselected	2.5	
1579	791013H07	1861 CMS X FC 605 T.O., mm		2.5
1580	791017H03	652016sl CMS X 662119sl T.O.		2.0
1581	791017H05	FC 606 CMS X 662119sl T.O.		2.5
1582	791017H07	(652016sl CMS X FC 605 T.O.)X 662119sl T.O.		2.5
1583	791917H08	1861 CMS X 662119sl T.O.		2.0

Table 1. Mean leaf spot and curly top ratings...Continued

ENTRY NO.	SEED NO.	DESCRIPTION	LEAF SPOT[1]	CURLY TOP[1]
1584	791018H04	FC 606 CMS X L53 T.O. M		4.0
1585	791021H03	1861 CMS X FC 606 T.O.		3.0
1586	791021H04	632028s1 CMS X FC 606 T.O.		3.0
1587	791021H06	(1861 CMS X 12166) X FC 606 T.O.		2.5
1588	791022H04	662119s1 CMS X 1861 T.O., mm		2.5
1589	791022H07	(652016s1 CMS X FC 605) X 1861 T.O., mm		4.5
1590	791022H08	(642027s1 CMS X 662119s1 T.O.)X 1861 T.O.,mm		2.5
1591	791022H09	(652016s1 CMS X 662119s1 T.O.)X 1861 T.O. mm		3.5
1592	791022H010	622112s1 CMS X 1861 T.O., mm		3.5
1593	791023H01	632028s1 CMS X 632028s1; 651151HOA, B; 661151HOA		4.5
1594	791023H02	FC606 CMS X 632028s1		4.0
1595	791023H04	1861 CMS X 632028s1; 651151HOA,B; 661151HOA		4.0
1596	791025H03	FC 606 CMS X 662112s1, 642063 T.O.		2.5
1597	791025H04	FC(504 X 502/2)CMS X FC 605 X 622112s1, 642063 T.O.		4.5
1598	751102H03	FC 608 CMS		3.5
1599	A78-44	FC606 T.O.		4.0
1600		LSR check, FC(504X502/2)X SP6322-0	3.0	
1601		ILSR check, SP5822-0	3.5	
1602		LSS check, Synthetic check	6.7	
1603		CTR check, US 41		4.5
1604		CTS check, US 33		6.4
	LSD .05		0.86	
	C.V.		12.9	

[1] Leaf spot and curly top ratings based on 0-10 scale with 0=no symptoms and 10=dead for curly top or complete defoliation for leaf spot.

Persistence of Benomyl Tolerance and Absence of Triphenyltin Tolerance in **Cercospora beticola** Isolates from Texas.--E. G. Ruppel

In 1973 we identified benomyl-tolerant strains of Cercospora beticola from the northern panhandle of Texas. In most cases, use of benzimidazole fungicides was discontinued, with triphenyltin and copper compounds substituted for leaf spot control. A report from Greece on the occurrence of triphenyltin-tolerant isolates of C. beticola, and an apparent decrease in the efficacy of this fungicide in Texas, prompted a test of 1982 isolates of the fungus from Texas for tolerance to triphenyltin as well as benomyl.

Leaves with typical leaf spot symptoms were collected by Holly Sugar Corporation personnel from various fields where triphenyltin had been used for disease control. Sporulation of the fungus was induced on the lesions, and 100 random single-spore isolations were made by standard procedures. After growth of the isolates on potato-dextrose agar (PDA) for 7 days, 4-mm-diameter mycelium-agar disks were transferred to petri dishes containing either benomyl at 1, 10, or 100 μg a.i./ml, or triphenyltin at 0.1, 1, or 10 μg a.i./ml. Colony diameters were measured 4 days after transfer. Benomyl-sensitive Colorado isolate C-1, and benomyl-tolerant Texas isolate H1-12 from 1973 were included as controls. Additionally, all isolates were grown on fungicide-free PDA.

All isolates, including the controls, grew on medium containing 0.1 or 1 μg a.i./ml. Thus, none of the 1982 isolates were less sensitive than the controls. However, absence of triphenyltin tolerance in these tests does not prove that tolerant strains do not exist in Texas. If tolerant strains comprise only a small proportion of the fungus population, much larger samples would be needed for their detection. Continued periodic monitoring of Texas isolates seems justified.

Of the Texas isolates plated on the benomyl medium, 100% grew on 1 μg, 59% grew on 10 μg, and 55% grew on 100 μg a.i./ml. The sensitive control failed to grow on 1 μg/ml benomyl. Thus, all of the 1982 isolates were tolerant of benomyl to some degree, and those growing on the highest concentration appeared to be as tolerant as our most tolerant 1973 isolate (H1-12). The long persistence of benomyl-tolerant strains confirms our findings in Arizona, and those reported from Greece. Apparently, genes imparting fitness and those for benomyl tolerance are inherited independently in C. beticola, although such characters are associated in some other fungi.

SUGARBEET QUALITY IMPROVEMENT RESEARCH: GENETICS, PHYSIOLOGY, AND METHODS (BSDF Project 53)

Quality Improvement by Post-storage Selection.-- R. J. Hecker, S. S. Martin and G. A. Smith.

Several years ago a selection project was commenced to test the hypothesis that post-storage beet quality was partially or completely conditioned by genes different from those conditioning quality at harvest. To test this hypothesis three cycles of selection were made starting with a heterogeneous population (SP6322-0). The roots in all three cycles of selection were harvested about October 15, placed in refrigerated storage at 5 C and 100% humidity, and analyzed 100 days later for sucrose, sodium, potassium, and amino N in the standard sucrose filtrate. Selections were based on a quality index calculated from these non-sucrose components. No plants weighing less than one standard deviation below the mean root weight were included among the selections. The selections in each cycle were interpollinated without progeny testing. These selections were made from beets grown both at optimum nitrogen fertility and excess N fertility (100 lbs/acre of additional N side dressed about June 15).

The populations resulting from the third cycle of selection were used as pollinators on a set of five male sterile testers in order to detect any effect that the selection may have had on combining ability.

The first phase of field testing of the selected populations and the combining ability hybrids was conducted in 1982 at optimum and high N fertility. However, it happened that the optimum fertility level was in fact high in fertility due to a large amount of unmeasured deep nitrogen. Consequently, there were practically no differences between the nitrogen treatments for any of the seven characters measured. The results in Table 1 show that there were significant differences among entries for all characters and significant interactions of entries and nitrogen treatments for all characters except root weight and milligrams amino N per 100 grams sucrose. Table 2 presents the means of the source population, various cycles of selection, and the combining ability test hybridizations. Quality improvement as measured by thin juice purity was made in beets at harvest. Only the first cycle of selection at high N failed to show a significant advance in purity. Generally lower quantities of amino N, sodium, and potassium were present in these cycles of selection; however, sodium was less responsive to selection than amino N and potassium. Sucrose generally increased as the number of cycles of selection increased, but root weight was significantly decreased in all selections, resulting in no significant change in recoverable sucrose.

Those selections made at optimum levels of fertility had slightly greater improvement in quality and sucrose, with less loss of root yield. Hence it appears that selection at an optimum level of fertility was superior to selection of beets grown at above optimum fertility. Perhaps the genetic differences were somewhat overwhelmed by the excess available nitrogen and the individual genotypes were not as completely reflected in the measured phenotype.

Since per se performance following selection is not important of itself because all commercial varieties are hybrids, the effect of this selection on combining ability is the result of greatest interest. The combining ability results at the bottom of Table 2 indicate that even though there was

improvement due to three cycles of selection, this improvement was not reflected in the resulting hybrid progenies. The mean hybrid performance of these third cycle populations was in no case significantly different from the mean hybrid performance of the source parent, SP6322-0. Hence our selection process failed to make improvements in this source as a pollinator on 'random' male steriles. It must be remembered, however, that this first phase measured quality and productivity at harvest while the objective was to improve post-storage quality. The final phase of the experiment to be conducted in 1983 will assess the post-storage quality. From both phases of the experiment we should be able to draw conclusions about the effect of post-storage quality selection on a pollinator parent destined for use in hybrids.

Table 1. Analyses of variance of quality and yield characters in post-storage quality selection experiment (Ex. 7, 82).

		Variable and significance						
Source of variation	df	Purity	AMN	Na	K	Suc.	Recov. suc.	Rt. wt.
Entries	21	**	**	**	**	**	**	**
Nitrogen treatments	1	NS	NS	NS	*	NS	NS	*
E x N	21	**	NS	**	**	**	**	NS
Residual	302							

* 5% level of significance.

** 1% level of significance.

NS Not significant

Table 2. Means of three cycles of mass selection for post-storage quality, and combining ability test means (Ex. 7, 82).

Description	Purity	Amino N	Na	K	Sucrose	Recov. suc.	Root wt.
	(%)	(--mg/100 g suc--)			(%)	(T/A)	(T/A)
Source; SP6322-0	79.7	.431	2.76	2.28	9.0	1.01	19.8
1st cy sel at opt. N	81.4	.384	2.46	1.94	9.7	1.02	17.2
2d cy sel at opt. N	82.2	.339	2.32	1.66	10.0	0.93	14.9
3d cy sel at opt. N	83.3	.301	2.07	1.54	10.5	0.99	14.7
1st cy sel at high N	80.1	.435	2.80	2.08	9.0	0.84	16.6
2d cy sel at high N	82.2	.338	2.42	1.53	9.8	0.85	14.2
3d cy sel at high N	83.0	.316	2.22	1.42	10.2	0.82	12.8
CMS's X SP6322-0	82.7	.341	2.20	1.75	10.1	1.14	20.4
CMS's X 3d cy sel opt. N	83.3	.314	2.05	1.63	10.5	1.22	20.3
CMS's X 3d cy.sel high N	83.8	.330	2.16	1.68	10.2	1.16	20.2
LSD(.05)	1.3	.048	0.35	0.17	0.6	0.15	1.8

<u>Sodium, Potassium, and Amino N in Fodder Beets</u>--S. S. Martin and G. A. Smith.

The Fort Collins 1981 Uniform Fodder Beet Trial (see a description in the 1981 Report) was used as a source of samples for determination of sodium, potassium, and amino N. This was the second year of the study; the previous year's results and methods used in both years were described in the 1981 Report. The two tests were not identical in cultivars included, so results are compared in each year to the commercial check, GW Mono Hy D2.

In this year's test, sucrose contents were markedly lower and sodium, potassium and amino N higher than in the previous test. The comparative results relative to the commercial check, Mono-Hy D2, however, were essentially unchanged. Sucrose was significantly higher in D2 and two other sugarbeet cultivars than in any of the fodder beets (Table 1). With chemical component data expressed on a volumetric basis (Table 1) and Duncan's multiple range test (probability 0.05) as the means test criterion, Zwaan Poly and all the fodder beet (FB) entries had significantly greater sodium concentrations than D2, Zwaan Poly and all FB entries except TC 2018 had significantly greater K content than D2, and three FB entries plus two checks were significantly lower than D2 in amino N content.

Table 1. Sodium, potassium, and amino N content of 12 fodder beet cultivars and four check cultivars. Data are in g/100 ml Al-clarified sucrose filtrate.

			- - - mg/100 ml Al filtrate - - -		
Entry	Description	% of fr wt Sucrose	Sodium	Potassium	Amino N
959	Lamono I	10.83 cde	12.9 cd	29.6 ab	3.62 bc
960	Lamono II	9.44 f	19.8 a	26.8 cde	4.03 bc
961	Kyros	9.62 ef	16.1 abcd	28.6 abc	2.65 c
962	Monovigor	11.17 cd	14.0 bcd	30.1 ab	3.69 bc
963	Barsein	10.85 cde	14.9 bcd	24.7 ef	3.12 bc
964	Monriac	9.75 ef	14.1 bcd	29.0 abc	4.18 bc
965	Monorosa	11.65 c	12.6 cde	29.4 ab	3.80 bc
966	Hugin	10.22 def	16.7 abc	29.0 abc	3.53 bc
977	Monovert	9.97 def	18.4 ab	24.9 def	3.87 bc
978	TC5/45-9	9.91 def	15.2 bcd	27.8 bc	2.92 c
979	Barb 79-1	10.34 def	13.3 cd	30.2 a	2.63 c
980	TC 2018	11.76 c	11.7 de	23.9 fg	3.80 bc
981	GW Mono Hy D2	16.41 a	4.9 f	21.8 g	4.48 ab
982	Zwaan Poly	14.41 b	11.8 de	26.9 cd	5.62 a
983	Beta 1237	16.58 a	8.4 ef	22.5 g	2.90 c
984	GW Mono Hy E4	16.63 a	6.3 f	22.0 g	3.77 bc
F-test		38.4**	7.98**	16.8**	2.75**

Within columns, values not followed by the same letter differ significantly by Duncan's multiple range test (0.05 level).

With data in g/100 g sucrose (Table 2), all the FB cultivars differed significantly from Mono Hy D2 in sodium content. Zwaan Poly and all FB had greater potassium contents than did GW D2 and the other two sugarbeet checks. Only Lamono II differed significantly from Mono Hy D2 in amino N content per unit sucrose, but about half the FB differed from the sugarbeet check with lowest amino N, Beta 1237.

Table 2. Sodium, potassium, and amino N content of 12 fodder beet cultivars and four check cultivars. Data are in g/100 g sucrose.

Entry	Description	% of fr wt Sucrose	---- g/100 g sucrose ---- Sodium	Potassium	Amino N
959	Lamono I	10.83 cde	0.94 cdef	2.12 abc	0.27 abc
960	Lamono II	9.44	1.77 a	2.24 ab	0.35 a
961	Kyros	9.62 ef	1.43 abc	2.35 a	0.23 abcd
962	Monovigor	11.17 cd	0.97 bcdef	2.08 bc	0.26 abcd
963	Barsein	10.85 cde	1.10 bcdef	1.77 de	0.23 abcd
964	Monriac	9.75 ef	1.20 bcde	2.32 ab	0.34 ab
965	Monorosa	11.65 c	0.87 defg	1.96 cd	0.26 abcd
966	Hugin	10.22 def	1.34 abcd	2.22 ab	0.28 abc
977	Monovert	9.97 def	1.48 ab	1.94 cd	0.31 abc
978	TC5/45-9	9.91 def	1.27 abcde	2.20 ab	0.24 abcd
979	Barb 79-1	10.34 def	1.11 bcdef	2.29 ab	0.21 cd
980	TC 2018	11.76 c	0.80 efgh	1.57 ef	0.26 abcd
981	GW Mono Hy D2	16.41 a	0.24 i	1.04 g	0.22 bcd
982	Zwaan Poly	14.41 b	0.66 fghi	1.45 f	0.31 abc
983	Beta 1237	16.58 a	0.40 ghi	1.05 g	0.14 d
984	GW Mono Hy E4	16.63 a	0.34 hi	1.04 g	0.19 cd
F-test		38.4**	7.16**	36.3**	2.14**

<u>The Effect of Benomyl on Some Chemical Constituents of Sugarbeet</u>.--G. A. Smith and S. S. Martin.

In the 1981 Sugarbeet Research Report we reported the results of a 2-year field study in which eight cultivars were sprayed with benomyl at 2-week intervals beginning June 25 each year. Significant reductions in amino N, total N and betaine occurred both years. Sodium, potassium, and chloride were also reduced, although not always significantly.

In 1982, we established a test to determine how the number and sequence of benomyl applications affected components of juice purity. Two commercial varieties and one experimental hybrid were evaluated under five treatment regimes. (Table 1). All benomyl spray treatments were at concentrations recommended for commercial control of cercospora leaf spot.

Table 1. Treatment regimes, benomyl study 1982.

Designation	Benomyl Applications	Sequence
6T	6	June 24, July 8, July 22, Aug 5, Aug 19, Sept 2
3T	3	June 24, July 22, Sept 2
1TE	1 (early)	June 24
1TL	1 (late)	Sept 2
OT	0 (control)	--

Results from the 1982 test may not be typical of a "normal" growing season. Planting was late and was followed by 1 month of very cool weather. Yields and sucrose data reflect the short season.

As in our previous studies, benomyl spray tended to reduce amino N, total N and betaine. The most consistent reductions occured with the 3 spray treatment (3T). For these three chemical components, all 3 cultivars showed reductions whereas with 6 benomyl applications only 2 of the 3 cultivars showed reductions in all 3 components.

Three applications were equally or more effective than six in reducing concentrations of non-sucrose juice components. Some information on the time to spray was obtained. All six chemical components determined (amino N, betaine, total N, Cl, K and Na) were reduced by the single late benomyl treatment (1TL) in two of the three cultivars tested. This compares to reductions in only one of three cultivars for each chemical component following a single early season (1TE) spray.

CLARIFICATION OF SUGARBEET EXTRACTS
(BSDF Project 81)

Sugarbeet Extract Clarification.--S. S. Martin

Antioxidants, polyphenol adsorbents, polyphenol oxidase complexing agents (copper chelators) and other polyphenol oxidase inhibitors, heavy metal chelators, and strongly basic anion exchange resins all have potential utility in extract clarification. Representatives of these classes, singly or in selected combinations, are undergoing laboratory testing as sugarbeet extract clarificants. Tests are made on frozen sugarbeet brei as well as on extracts from fresh brei, and all tests are compared on the basis of polarimetric sucrose values relative to duplicate (paired) aluminum-clarified extracts. Results will be reported at the completion of the test series.

OTHER RESEARCH OF INTEREST TO BSDF MEMBERS

Cercospora and Rhizoctonia Resistance Evaluation of Sugarbeet Accessions from China---G. A. Smith, R. J. Hecker, and E. G. Ruppel

Fifteen sugarbeet accessions from China (PRC) were evaluated in replicated field tests for their resistance to leafspot and/or rhizoctonia root rot. These are the accessions received by Dr. McFarlane in a recent official sugarbeet germplasm exchange between USDA-ARS and PRC. These accessions are all multigerm, probably open pollinated varieties.

Results of the tests are summarized in Table 1. For Rhizoctonia resistance, none of the 15 entries tested were significantly more resistant than the Rhizoctonia susceptible check (entry 367). Several of the entries (352, 357, and 358) were significantly more susceptible than the susceptible check. We concluded that little if any useable genetic resistance to Rhizoctonia exists in this set of entries.

For Cercospora resistance, ten entries were not significantly different from the resistant check (entry 368). Since our long term resistant check is very resistant and our epidemic was moderately severe, we concluded that this set of Chinese accessions has several entries with good cercospora resistance.

We grew stecklings of the better entries and will obtain seed increases in the summer of 1983.

Table 1. Cercospora and Rhizoctonia resistance of Chinese accessions; cercospora rating; and rhizoctonia disease index (DI) [1]

ENTRY NO.	SEED NUMBER AND DESCRIPTION	RHIZOC DISEASE INDEX	LEAF SPOT RATING
351	A82-56 Fan yu 1 (P.I. 467869)	5.4	3.8
352	A82-57 Fan yu 2 (P.I. 467870)	6.1	3.5
353	A82-58 Gong fan 1 (P.I. 467871)	5.3	3.5
354	A82-59 Gong nong (P.I. 467872)	4.5	5.5
355	A82-60 Nei meng 5 (P.I. 467873)	5.1	5.3
356	A82-61 Shuang feng 5 (P.I. 467874)	4.9	4.3
357	A82-69 Shuang feng 6 (P.I. 467875)	5.7	4.5
358	A82-70 Shuang feng 8 (P.I. 467876)	5.6	3.8
359	A82-62 Shuang feng 303 (P.I. 467877	5.2	3.5
360	A82-63 Shuang feng 304 (P.I. 467878)	4.6	3.8
361	A82-64 Tao yu 1 (P.I. 467879)	5.5	4.0
362	A82-65 Tao yu 2 (P.I. 467880)	4.8	4.8
363	A82-66 Tien yen 5 (P.I. 467881)	4.9	4.5
364	A82-67 Tien yen 3 (P.I. 452434)	5.4	-
365	A82-68 Tien yen 4 (P.I. 452435)	4.3	-
366	751080H FC 703; Rhizoc. resistant check	1.8	-
367	751046H FC 901; Rhizoc. susceptible check	4.6	-
368	761042H02 Leaf spot resistant check	-	3.5
369	771056H Leaf spot susceptible check	-	6.3
L.S.D. (.05)		0.8	1.1

[1]Rhizoctonia evaluations based on randomized complete block design with 4 replications. Cercospora evaluations based on randomized complete block design with 2 replications. Epidemics for both diseases were artificially induced.

Development of a Trisomic Series in Homozygous Sugarbeet--R. J. Hecker and I. Romagoza

This is the final year of a 5-year project devoted to the development of a trisomic series in homozygous sugarbeets. The project was funded under the US-Spanish Program for Scientific and Technological Cooperation. This was a basic research project to identify, isolate, and describe the nine possible trisomic types in sugarbeet. We have identified and cytologically described all nine trisomics. However, we have been able to get seed production from only six of the nine types. We are currently trying to recover the three trisomic types that died before seed production in order to have trisomic stock seed available of all nine types. We are nonetheless proceeding with stock seed increases of the types that we have. When seed of these stocks is increased, it will be made

available to scientists throughout the world. Hopefully, some scientists may be able to use these trisomics to establish all linkage groups in sugarbeet and assign known genes to their correct linkage groups. The morphological and cytological identification of trisomic plants is very difficult yet critical to the correct use of trisomics. The trisomics that we have isolated and identified have all come from NB1 or the annual isogenic line of NB1. Our attempts to isolate viable trisomics from three other homozygous inbred lines were unsuccessful due to death of the majority of the trisomic plants before seed production. It would seem that the homozygous line NB1 is more tolerant of the nine different trisomic conditions than the other three genotypes.

This has been a basic genetic research project that will provide a foundation for development of information on linkage relationships of known genes in sugarbeet, which in turn is basic to any significant genetic engineering effort. One deficiency in sugarbeet remains, that is, the dearth of identified single gene characters in sugarbeet. No significant effort is apparently being made to identify or create mutant characters. To successfully apply genetic engineering techniques to beet, much more needs to be known about basic genetics in the species.

SUGARBEET RESEARCH

1982 Report

Section D

North Dakota Agricultural Experiment Station, Fargo, North Dakota

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Cooperation:

American Crystal Sugar Company
Minn-Dak Sugar Cooperative
Minnesota Agricultural Experiment Station
Sugarbeet Research and Education Board of Minnesota and North Dakota

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CONTENTS

	Page
ROOT INHABITING BACTERIA by W. M. Bugbee	D2
SUGARBEET BREEDING by L. G. Campbell and J. M. Bond. . . .	D4
MEASURING INTERNAL CO_2 UNDER FIELD CONDITIONS by D. F. Cole	D6
IDENTIFICATION OF LOW AND HIGH INTERNAL CO_2 GENOTYPES UNDER FIELD AND LABORATORY CONDITIONS by D. F. Cole. . .	D8
RESPONSE OF SUGARBEETS TO MULTIPLE PESTICIDES by D. F. Cole and A. Dexter	D12
EFFECT OF FREEZING ON SUGARBEET STORAGE LOSSES by D. F. Cole	D14

ROOT INHABITING BACTERIA

W. M. Bugbee

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A partial purification of invertase from a root inhabiting isolate of Pseudomonas fluorescens has been completed. The yield of invertase extracted from the bacterium was increased when lysozyme was used along with mechanical disruption of cells. Protein was precipitated with ethanol and fractionated and partially purified by gel filtration and ion exchange. Fractionation of the extract through the calibrated Sephacryl gel indicated the molecular weight of the invertase at approximately 88,000 daltons. One electrophoretic run in a non-denaturing homogenous polyacrylamide gel (PAA) indicated a molecular weight of approximately 50,000 daltons. Three protein bands developed from a sample size of 5 µg of protein. The invertase band was identified by incubating the gel in standard buffered sucrose then detecting released fructose in the gel by reacting with triphenyltetrazolium chloride. The isoelectric point of the enzyme was estimated using disc electrophoresis. The invertase was electrophoresed in 10% polyacrylamide gels containing appropriate ampholytes. After electrophoresis, the pH gradient of the gels was measured with a scanner then the gels were sliced into 2 mm sections. The sections were placed in 0.3 ml of .2 M KPB pH 7.5 for 1 hr then .2 M of .75 M sucrose was added and incubated at 30^{0} for 1 hr. The entire reaction mixture was assayed for reducing sugars. Measurements from one trial indicated the isoelectric point of this invertase is pH 6.1.

Invertase was incubated in a 0.2 M KPB pH series at 0.5 unit increments from 4.5 to 8.0. The greatest activity occurred at pH 6.5. The enzyme hydrolyzed sucrose and raffinose but not maltose at pH 6.5 indicating this invertase is a fructofuransosidase.

Experiments have been in progress to learn how these nonpathogenic bacteria enter sugarbeet plants. A culture of Pseudomonas fluorescens and a culture of Corynebacterium sp. that was isolated from healthy roots and a leafspoting culture of P. syringae from a sugarbeet leaf were used. All three bacteria have been induced to grow on nutrient agar (NA) supplemented with 50 µg/ml of rifampicin, 1000 µg/ml streptomycin sulfate and 100 µg/ml of mercuric chloride (RSHg cultures). Flowering sugarbeet plants were inoculated by spraying suspensions of mutant cultures three times at 7 day intervals. Seeds were assayed for bacteria 10 days after the last inoculation. Bacterial growth on the NARS agar indicated that mutant P. fluorescens bacteria were deeply embedded in the inoculated seed. Whether the bacteria were able to penetrate embryonic tissue or were merely on the surface of the seed coat has not been determined.

The mutant bacteria were able to penetrate the root system and systemically colonize the plant. The RSHg bacteria were applied to the soil of pasteurized, potted soil at the time sugarbeet seedlings were emerging. When plants were at the 3-4 leaf stage, roots, hypocotyls, petioles and leaves were surface sterilized by flaming-off 95% ethanol, then homogenized in sterile water in a sterile tissue homogenizer. Samples of the homogenates were assayed and showed that *P. fluorescens*, *P. syringae* and *Corynebacterium* sp. were within the roots, hypocotyls, petioles, and leaves. All twenty of randomly selected colonies of mutant *P. syringae* that were reisolated from leaf tissue homogenate were still pathogenic as shown by leaf lesions following inoculation. These results have shown that these three bacteria penetrated the sugarbeet through the root system and moved upwards into above ground tissues. Movement most likely was passive through the xylem.

SUGARBEET BREEDING

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The primary goal of the USDA breeding program is to reduce storage losses by developing sugarbeet lines with low respiration rates during storage and resistance to important storage rot pathogens (*Phoma betae*, *Botrytis cinerea*, and *Penicillium claviforme*). Lines with the desired traits have been identified and are being tested to confirm their superiority. Replicated tests conducted in 1980 and 1981 have provided preliminary information on relationships among traits for improved storability as well as relationships of these traits to important agronomic and quality characteristics. Table 1 presents a summary of four years' progress in selecting for low respiration rate.

Table 1. 1981 Low Respiration Selections

	Internal CO_2 Concentration*	Sucrose	Purity
	%		
Checks,	2.27	11.5	85.7
Experimental Lines, Average	1.45	9.6	81.5
Individuals Selected for Increase	0.94	---	---

* Lower carbon dioxide (CO_2) percentage indicates lower respiration rate and thus reduced sugar loss.

Checks = GW-R1, ACH 14, Beta 1345

Original selection was solely for low internal CO_2, so some lines have unacceptable quality. Sucrose content of the experimental lines selected for future evaluation ranged from 6.3 to 14.6%. These data indicated that low respiration rate can be incorporated into lines with acceptable quality.

Table 2 summarizes the progress in selecting for rot resistance. Almost all of the selected lines possess relatively high levels of resistance to all three rot fungi. The range of sucrose concentration observed in this material indicated that rot resistance and commercially acceptable quality are not incompatible traits.

Table 2. 1981 Rot Resistant Selections

	Phoma	Botrytis	Penicillium	Sugar
	Rating*			%
Checks,	2.7	4.0	1.4	12.7
Experimental Lines, Average	1.6	2.2	0.7	11.2
Individuals Selected for Increase	0.9	1.0	0.5	---

* 0 = no rot to 5 = completely rotted

Checks = GW-R1, Beta 1345, and ACH 14

Composite crosses which included 52-307, L-53, C-17, 1861, and low respiration selections from the world collection in their parentage were evaluated on an individual root basis for internal CO_2 concentration and sucrose percentage. Improvements in internal CO_2 concentrations were similar to that observed in material selected almost exclusively for low CO_2 level, however, sucrose content remains 2-3% below the check cultivars after two cycles of selection. In a composite cross originating from low respiration and rot resistant selections, selection for low internal CO_2 appeared to be moderately successful, however, selection for rot resistance resulted in only minor improvement. Further research is needed to determine if there is a negative association between low internal CO_2 concentration and resistance to any or all of the rot fungi.

Measuring Internal CO_2 Under Field Conditions

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Internal CO_2 levels are usually measured in sugarbeet roots or in fleshy fruits, e.g., apples in the laboratory. However, it may be desirable to measure internal CO_2 during plant development in the field. This study was initiated to determine some of the factors affecting internal CO_2 levels of sugarbeet roots under field conditions.

Seed of two commercial cultivars were planted on May 24, 1982. Eight rows of each cultivar were planted in a north-south direction. To measure the effect of leaf removal on internal CO_2, four rows of each cultivar were defoliated with a rotobeater. Twenty to 24 consecutive roots in a defoliated row (excluding damage on small roots) and in an adjacent non-defoliated row (excluding small roots) of each cultivar were cored and sealed with a serum stopper. Cultivar 1 was cored on the west side of the roots and cultivar 2 on the east side. Gas samples were removed at 7 a.m. and 1 p.m. and evaluated for internal CO_2 with a infrared gas analyzer.

To measure the effect of core position on internal CO_2, cores were removed on consecutive defoliated beets, excluding damaged or small roots. Every fourth root was cored on the same side. Ten roots were cored for each position (north, south, east, west). Gas samples were analyzed for CO_2.

Internal CO_2 levels in excess of 10% were measured on some roots in preliminary tests. The data indicates that internal CO_2 levels increase during the day (Table 1). The roots that were defoliated had lower internal CO_2 levels than non-defoliated roots. Internal temperature of the roots increased about 11 F on the defoliated roots and about 9 F on the non-defoliated roots on August 25 between 7 a.m. and 1 p.m. A similar trend was noted on August 26. The data indicate that removal of the leaves affects the respiration rate regardless of the time of day. A small greenhouse study was initiated to verify these data under uniform soil and air temperatures. The roots (removed from the field in late October) were planted in soil tanks. However, some of the roots bolted and produced seed stalks. In non-bolting roots, a similar trend was noted in internal CO_2 levels as found in the field. In bolting roots a reverse trend was observed, e.g., defoliated bolters had higher levels of internal CO_2 than non-defoliated bolters. Additional data is needed to verify the effect of defoliation and bolting on internal CO_2 levels.

Core position did not influence the internal CO_2 level (Table 2). The cores were approximately 6 cm in depth, which may have masked any differences. Large differences were noted between the 7 a.m. and 1 p.m. levels. Surface temperature (measured with a infrared thermometer) of the roots were fairly uniform and slightly below or at ambient temperatures at 7 a.m. However, at 1 p.m. the north side was near or below ambient and the south side was up to 9 C above ambient.

Table 1. Effect of date, time, and leaf removal on internal CO_2 in sugarbeet roots. Roots were defoliated and sampled in the field.

Cultivar	Date	Time	n	Leaves removed	Leaves intact
				%	%
1	Aug 25	7 a.m.	24	1.9 1/	3.0
		1 p.m.	24	5.0	5.7
2	Aug 25	7 a.m.	20	3.1 2/	4.2
		1 p.m.	20	6.9	8.6
3	Aug 26	7 a.m.	20	3.4 2/	4.1
		1 p.m.	20	6.2	7.2

1/ All samples from west side of beet.

2/ All samples from east side of beet.

Table 2. Effect of date, time, and position of plug on internal CO_2 in sugarbeet roots. Roots were defoliated and sampled in the field.

Cultivar	Date	Time	Position of Plug 1/ North	East	South	West
			%	%	%	%
1	Aug 24	1 p.m.	8.2	8.7	8.2	8.4
	Aug 25	7 a.m.	3.2	2.8	3.4	2.9
	Aug 25	1 p.m.	6.5	6.5	7.2	6.0
2	Aug 26	7 a.m.	3.2	2.9	3.5	3.1
	Aug 26	1 p.m.	5.6	5.6	6.5	5.4

1/ Plug was removed on side of beet 2 cm below lowest leaf scar. Rows were oriented in a N-S direction.

Identification of Low and High Internal CO_2 Genotypes Under Field and Laboratory Conditions

D. F. Cole

Previous research has shown that internal CO_2 levels are correlated with respiration rates in sugarbeet roots. Selection for internal CO_2 levels was accomplished after the sugarbeet roots were in storage (5 C) for 60-90 days after harvest. A germplasm line (F1003) with low internal CO_2 levels was released in 1982. The objectives of this study were to determine if germplasm with low or high levels of internal CO_2 could be identified under field conditions or earlier in the storage period.

Three separate tests were initiated in the spring of 1982. Each test (A, B, or C) had 5 entries with 4 replications. Seed were planted on May 24 in 4 rows spaced 22 inches apart in an east-west direction. Plots were 60 ft in length. Antor and TCA were incorporated into the soil before planting.

One-third of the plants in each plot were defoliated with a rotobeater on August 25, September 14, or October 26. The roots in the two center rows were divided into two sets (10 roots each) in test A and into three sets (10 roots each) in tests B and C. In test A, every other root (excluding damaged or extremely small roots) was plugged by removing a core of tissue (2 cm below lowest leaf scar) with a cork borer and the cavity sealed with a serum stopper. In test B and C, every third root was plugged. All cores were removed from the north side of the roots. No roots were cored in the field for the October 26 harvest due to excessive soil moisture and lateness in the growing season.

Gas samples were removed (7 a.m.) from the roots 2 or 3 days after the cores were removed. The gas samples were immediately transported to the laboratory and analyzed for CO_2 with a infrared gas analyzer.

The roots were harvested manually and placed into storage at 5 C in perforated plastic bags. In each test, gas samples from the roots cored in the field were evaluated for internal CO_2 after 3 or 4 days storage at 5 C.

In test B and C, the second sample of roots were cored in the laboratory immediately after harvest and evaluated for internal CO_2 after 3 or 4 days storage at 5 C. In test A, B, and C the remaining sample of roots were stored for 30 days at 5 C, cored and evaluated 3 or 4 days later for internal CO_2.

After each set of roots were evaluated for internal CO_2 at 5 C, they were stored for an additional 30 days and evaluated again for internal CO_2. The serum stoppers remained in the roots for the entire sampling period.

Only data for the roots cored in the field and those stored for 30 days at 5 C, are included in this report. Correlation coefficients between the initial CO_2 levels and subsequent measurements are reported. Data not included showed similar results.

The data indicated that genetic differences in internal CO_2 levels could be detected under field and laboratory conditions (Table 1). The seed of low and high internal CO_2 lines were mixed in equal porportions (w/w) before planting. The seed were mixed so that large differences in internal CO_2 levels should exist betwen adjacent plants in the field. Generally, the mixed entries had the highest amount of variability in the data, which was expected.

The Phoma resistant lines usually had the highest internal CO_2 levels when evaluated at 5 C after 60-90 days storage in previous test. The results reported herein are in agreement with previous observations.

Several problems are encountered in measuring internal CO_2 levels under field conditions. In order to core most of the roots in the field, a small amount of soil had to be removed so that the core could be removed 2 cm below the lowest leaf scar. Removing a large number of cores (200 at each sampling in these trials) requires a considerable amount of time in a kneeling position. Internal CO_2 is extremely sensitive to temperature. Therefore, some difficulties in comparing data over time are encountered due to changes in soil and air temperature. One advantage, which offsets some of the negative aspects, is that only selected genotypes would be harvested.

The CO_2 levels generally decreased in the roots after storage at 5 C for 3 or 4 days compared to levels measured in the field. A general increase was noted in internal CO_2 at 5 C with each harvest (Table 1). However, after the roots were stored for 30 days, the roots from harvest 3 generally had lower CO_2 levels than the roots harvested earlier.

The correlation coefficients between the initial CO_2 level and subsequent measurements indicated that selection of genotypes could be made up to 30 days after the roots were cored (Table 2). All correlation coefficients reported in Table 2 are significant at the $p = 0.01$ level except for Test B, harvest 2, which is significant at the $p = 0.05$ level. The low correlation reported for Test B, harvest 2 can not be explained.

These data indicate that selection for internal CO_2 could be initiated in the field in the late summer or early fall. Also, the roots could be harvested, stored for 3 or 4 days at 5 C and then evaluated for internal CO_2. Selection in the field or earlier in the storage period would allow for a larger population of roots to be evaluated in a breeding program. Also, less storage space would be required since non-selected genotypes could be immediately discarded. We have evaluated up to 1600 roots per day with 3 people.

Table 1. Internal CO_2 levels increased in sugarbeet roots during the growing season and after storage.

		Fresh [1/]								
		Field			5 C			Stored [2/]		
Test	Entry [3/]	Harvest [4/] 1	2	3	1	2	3	1	2	3
		% CO_2								
A	Commercial	1.6 [5/]	1.9		1.2	1.7	1.9	1.4	1.3	0.9
	Commerical	2.0	2.4		1.5	2.2	2.1	1.6	1.3	1.1
	High CO_2	3.0	2.9		2.0	2.5	3.4	2.2	1.7	2.2
	Low CO_2	2.4	2.2		1.6	2.1	2.5	1.4	1.1	1.1
	High-low mix	2.4	2.4		1.6	2.1	2.8	1.5	1.5	1.4
B	High-low mix	2.4	2.1		1.0	2.2	2.5	2.2	1.1	1.2
	High-low mix	3.0	2.4		1.2	2.3	2.4	2.2	1.2	1.3
	High-low mix	3.5	2.4		1.4	2.4	2.2	2.4	1.6	1.6
	Low CO_2	1.9	1.4		0.8	1.4	1.5	1.7	1.0	0.8
	Commercial	2.8	2.2		1.1	2.2	2.4	2.4	1.3	1.3
C	Commercial	2.1	2.1		1.2	2.0	2.5	2.0	1.5	1.4
	Commercial	2.4	2.6		1.3	2.4	2.7	2.3	1.8	1.1
	Low CO_2	1.7	1.7		0.8	1.4	2.6	1.4	1.1	0.9
	Phoma resistant	4.3	4.2		1.8	3.6	3.5	2.8	2.3	1.9
	Phoma resistant	3.3	2.8		1.7	2.7	2.8	2.2	2.0	1.7

1/ Roots were defoliated and plugged in the field. Field samples were obtained at 7 a.m. CDT on day of harvest. After harvest, the roots were stored for 3-4 days at 5 C.

2/ Roots were harvested and stored for 30 days at 5 C. Roots were plugged and CO_2 measured after an additional 3-4 days storage at 5 C.

3/ Different commercial cultivars and high and low CO_2 selections were planted in each test.

4/ Harvest 1 = Aug. 27-31. Harvest 2 = Sept. 16-17. Harvest 3 = Oct. 27. No field measurements were made for harvest 3 because of excessive soil moisture.

5/ Average of 4 replications with 10 beets/replicate.

Table 2. Correlation coefficients of CO_2 levels measured in sugarbeet roots at various intervals before and after harvet (n = 200).

		Fresh 1/			Stored 2/
Test	Harvest 3/	A 4/	B	C	D
A	1	0.88**	0.66**	0.73**	0.87**
B	1	0.93**	0.85**	0.89**	0.89**
C	1	0.86**	0.65**	0.65**	0.85**
A	2	0.88**	0.69**	0.78**	0.85**
B	2	0.93**	0.88**	0.88**	0.14*
C	2	0.89**	0.66**	0.77**	0.81**
A	3				0.90**
B	3				0.75**
C	3				0.82**

1/ Roots were defoliated and plugged in the field. Field samples were obtained at 7 a.m. CDT on day of harvest. After harvest, the roots were stored for 3-4 days at 5 C.

2/ Roots were harvested and stored for 30 days at 5 C. Roots were plugged and CO_2 measured after an additional 3-4 days storage at 5 C.

3/ Harvest 1 = Aug. 27-31. Harvest 2 = Sept. 16-17. Harvest 3 = Oct. 27

4/ A = Field vs. initial level at 5 C. B = Field vs. level after 30 additional days storage. C = Initial 5 C level vs. level after 30 additional days storage. D = Initial level of stored roots vs. level after 30 additional days storage.

RESPONSE OF SUGARBEETS TO MULTIPLE PESTICIDES

D. F. Cole and Alan Dexter

Manual labor for weeding and thinning of sugarbeets is being replaced by the use of herbicides, planting to stand, mechanical thinners, and other mechanical methods to control weeds. Also, various chemicals may be used to control sugarbeet insects or diseases. Therefore, sugarbeet plants may be subjected to multiple pesticides for weed and insect control during growth.

Previous data indicated that commercial cultivars were least affected by preplant and post-emergence herbicides when compared to inbreds and F_1 hybrids. EPTC (Eptam) and desmedipham (Betanex) have influenced sugar yield in selected commercial cultivars.

In most production areas, sugarbeet roots are stored in large unprotected piles after harvest and sucrose losses are affected by production practices. Our objectives were to determine the effect of cultivars, EPTC, desmedipham, and aldicarb (Temik) alone and in all combinations on yield and quality at harvest and on sucrose losses during post-harvest storage.

Three commercial cultivars, 'ACH-14', 'Mono-Hy R 1', and 'Hilleshog 833', were planted in a randomized complete block design with six and eight replications in 1980 (two locations) and 1981 (one location), respectively. Pesticide treatments were assigned to main plots and cultivars to subplots. Subplots were 7.5 m long and four rows wide, spaced 56 cm apart. EPTC was applied at 2.5 lbs per acre and incorporated with a rototiller prior to planting in the spring. Aldicarb was applied at 1.5 lbs per acre in the row when the seed were planted. Seed were planted 4 cm deep in early May of both years. Desmedipham was applied at 1.0 lb per acre when the sugarbeet plants had two to four true leaves. All plots were thinned and maintained weedfree after the desmedipham application.

The center two rows of each plot were harvested in early October both years. In 1980, the Moorhead location was harvested with a mechanical lifter. The Fargo location was harvested manually both years. The roots were washed, weighed, and divided into two subsamples. One subsample was analyzed for sucrose and purity using standard procedures. The other subsample was placed into a perforated plastic bag and stored at 5 C and near 100% relative humidity for 120 days. After storage, the roots were analyzed for sucrose and purity. Storage data was corrected for weight loss. The data from each experiment was analyzed separately and then combined over experiments.

Analysis of the individual test indicated that the cultivars were significantly different in yield at harvest and in quality components at harvest and after storage in each test. None of the pesticide treatments or interactions among cultivars and pesticides were consistently significant over all individual tests before or after storage. Some of the main effects and interactions were significant at harvest but not after storage and vice-versa.

The combined analysis indicated the individual experiments differed in yield and quality components before and after storage (Table 1). The growing conditions were more favorable in 1981 than in 1980. Cercospora leaf spot was more prevalent on the plots in 1980 than in 1981. In 1980, storage losses were higher for the Moorhead location than Fargo because of the mechanical harvesting at the Moorhead location. Also, Cercospora leaf spot was more prevalent at the Moorhead location and may have influenced storage losses.

Cultivars were significantly different for yield and quality before and after storage (Table 1). A significant experiment by cultivar interaction was detected for yield but not for any of the quality components before or after storage. Campbell and Kern found that cultivars differ in their genetic potential to respond to favorable environments. Yield of Mono-Hy R 1 and Hilleshog 833 increased 48 and 81%, respectively, at the Fargo location in 1981 compared to the Moorhead location in 1980.

EPTC, desmedipham, and aldicarb alone or in any combination did not affect yield or quality components at harvest or after storage at the 1 or 5% level of probability except that EPTC caused a significant increase in yield (Table 1). The cultivar by aldicarb interaction was significant at the 10% level of probability for sucrose per ton before and after storage. Sucrose per ton increased 0.6 and 1.0% in ACH-14 and Hilleshog 833, respectively, when treated with aldicarb.

These data indicate that cultivars with lower recoverable sucrose per ton at harvest had higher losses of sucrose during storage (Table 1). Also, the data indicates that the use of approved pesticides used alone or in combination does not reduce yield or quality at harvest or cause an increase in storage loses of sucrose during post-harvest storage. In some instances, pesticides improved yield or quality at harvest or reduced storage losses. None of the pesticides used in these tests had a detrimental affect at harvest or after storage on any of the commercial cultivars tested.

Table 1. Effect of locations, cultivars, and pesticides on sugarbeet yield and quality at harvest and on quality after 120 days storage at 5 C and near 100% relative humidity.

Variable	Yield	Sucrose Harvest	Sucrose Storage	Purity Harvest	Purity Storage	Sucrose per ton Harvest	Sucrose per ton Storage	Sucrose per ton Loss
	T/A	%		%		lbs		%
Locations								
Moorhead, 1980	13.0	14.6	13.5	92.7	92.3	249	228	8.4
Fargo, 1980	13.7	14.4	13.4	91.7	91.7	239	223	6.7
Fargo, 1981	20.9	15.7	14.8	93.6	92.4	273	250	8.4
Cultivars								
ACH-14	14.9	15.7	14.8	93.2	92.9	272	253	7.0
GW-R1	17.2	14.6	13.6	93.0	92.3	251	230	8.4
H-833	17.1	14.6	13.5	92.2	91.2	245	222	9.4
EPTC								
No	16.1	15.0	13.9	92.8	92.2	256	235	8.2
Yes	16.7	15.0	14.0	92.8	92.2	256	235	8.2
Desmedipham								
No	16.3	15.0	14.0	92.9	92.2	256	235	8.2
Yes	16.5	15.0	14.0	92.7	92.1	255	235	7.8
Temik								
No	16.2	14.9	14.0	92.7	92.0	255	234	8.2
Yes	16.6	15.0	14.0	92.9	92.3	257	236	8.2

EFFECT OF FREEZING ON SUGARBEET STORAGE LOSSES

D. F. Cole

Sugarbeet roots freeze at -2 to -3 C depending on the duration of the temperature and amount of leaf canopy. Sugarbeet roots that are frozen are more susceptible to storage losses. Vukov summarized a number of trials and found that the average daily loss of sucrose increased 10 fold in frozen beets compared to nonfrozen beets during storage.

In 1981, a large percentage of the sugarbeet crop in the Red River Valley of North Dakota and Minnesota was exposed to temperatures that caused the roots to freeze before harvest. A small portion of the sugarbeet crop is usually exposed to freezing temperatures in the field. In most instances the companies are able to process the frozen beets immediately after harvest. However, in 1981 the companies could not immediately process the crop because of the large tonnage involved which necessitated long-term storage of frozen beets.

The objectives of this study were to determine the effect of delaying harvest after the freeze on the root microflora, sucrose losses, and if scalping increased the sucrose losses.

Sugarbeet roots were harvested on four dates (Oct. 19, 21, 27, and Nov. 2). The freezing temperatures and snow occurred between October 20-23. Therefore, the beets harvested on Oct. 27 and Nov. 2 were harvested approximately 5 and 10 days after the freeze. The roots harvested on Oct. 19 were not exposed to the freeze and represent the control treatment. The roots harvested on Oct. 21 were harvested after the snow and before the coldest temperatures. The canopy was removed on Oct. 21 for the beets that were harvested on Oct. 21, 27, and Nov. 2. The roots were manually harvested from two rows, 9 m long, spaced 56 cm apart. There were five replications.

After harvest, the roots were washed and divided into two subsamples. One subsample was analyzed for sucrose and purity using standard procedures. The other subsample was placed into a perforated plastic bag and stored at 5 C and near 100% relative humidity for 120 days. During storage, cores (1x5 cm) were removed from the nonfrozen (Oct. 19 harvest) and frozen (Nov. 2 harvest) beets. Cores were removed from the root (6 cm below the lowest leaf scar) and crown tissue (1.3 cm above the lowest leaf scar) of four roots per replicate. Juice was obtained from the cores, diluted and plated in triplicate to determine the resident microflora (bacteria and yeast) population. After storage, the roots were analyzed for sucrose and purity. The data was corrected for weight loss.

The data indicated that the beets harvested approximately 5 days after the freeze had the highest storage losses (Table 1). Roots harvested 10 days after the freeze had substantially higher losses than the control, but less than the beets harvested at 5 days after the freeze. The roots harvested on Oct. 21 during the freeze had similar losses as the control roots harvested on Oct. 19. The microflora was significantly increased by the freeze (Table 2). The crown had more microflora than the root tissue, especially in the frozen crown of the scalped roots. Scalping increased the number of the microflora in both the root and crown tissue of frozen and nonfrozen beets. The increase

in the microflora induced by the freeze may partially explain why the frozen beets had higher storage losses of sucrose. The microflora were not identified to genus and species, however, it is known that some of the microflora produce compounds that can affect processing such as Dextrans.

Table 1. Effect of harvest date on recoverable sugar (at harvest and after storage*) from sugarbeets before and after the roots were subjected to low temperatures in the field on Oct. 20-23, 1981.

Harvest date	Recoverable sucrose					
	Scalped			Flailed		
	harvest	storage	loss	harvest	storage	loss
	— lbs ton $^{-1}$ —		%	— lbs ton $^{-1}$ —		%
Oct. 19	239	210	12.1	236	212	10.2
Oct. 21	238	205	13.9	232	206	11.2
Oct. 27	235	156	33.6	234	169	27.8
Nov. 2	226	180	20.4	218	188	13.8

* Stored for 120 days at 5 C and near 10 % relative humidity.

Table 2. Effect of freezing, tissue, and type of leaf removal on the resident microflora population of stored sugarbeet roots.

Variables					
Frozen	Tissue	Type of leaf removal	# Microflora per ml of juice	Variable	# Microflora per ml of juice
			X10^6		X10^6
No	Crown	Flailed	1.12	Flailed	3.19 b*
		Scalped	3.25	Scalped	5.96 a
	Root	Flailed	0.78		
		Scalped	2.56	Crown	5.91 a
				Root	
Yes	Crown	Flailed	6.60		3.24 b
		Scalped	12.65		
	Root	Flailed	4.24	Frozen	7.21 a
		Scalped	5.36	Non-frozen	1.93 b

* Means followed by the same letter are not significantly different according to Duncan's Multiple Range Test.

SUGARBEET RESEARCH

1982 Report

Section E

Michigan Agricultural Experiment Station, East Lansing, Michigan

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CONTENTS

Page

MAIN ACCOMPLISHMENTS AT EAST LANSING DURING 1982 . . . . . E2

PUBLICATIONS E3

HYBRIDS by G. J. Hogaboam, J. W. Saunders, and C. L. Schneider. E5

PRESENT APPLICATION OF SHOOT CULTURE IN EAST LANSING BREEDING PROGRAM by J. W. Saunders E9

TESTS OF FUNGICIDES TO CONTROL CERCOSPORA LEAF SPOT AND RHIZOCTONIA CROWN ROT DISEASES OF SUGARBEET by C. L. Schneider. E10

BREEDING SUGARBEETS FOR RESISTANCE TO BLACK ROOT AND LEAF SPOT by G. E. Coe E13

- Testing for Black Root Resistance. E14
- Selecting for Resistance to Southern Root Rot. E15
- Selecting for Low Content of Nonsucrose Solubles E17
- Development of Soil-Free Sugarbeet Taproots. E18
- Cold Temperature Germination Selections. E18
- Monogerm O-types E19

Main accomplishments at East Lansing during 1982

1. Greenhouse screening tests aid in retention and improvement of Aphanomyces black root disease resistance. Breeding lines at this station are regularly evaluated in greenhouse inoculations that show degree of resistance to *Aphanomyces cochlioides*. Among 336 lines derived from plants selected for resistance in 1977 - 1982 tests, 51.8 pct. were rated superior in resistance and 48.2 pct. were rated the same as commercial variety, US H20, whereas, among 1870 lines derived from other sources, 19.8 pct. were rated superior, 79.5 pct. were rated the same, and 0.7 pct. were rated inferior to US H20. Resistance to *Aphanomyces* is needed in the area to insure a good stand and high quality crop in those years when early planting cannot be accomplished because of high rainfall. It is essential to have at least as much resistance as US H20.

2. Establishment of shoot regeneration technique with callus of several genotypes of sugarbeet. Shoot regeneration came by way of a high frequency habituated callus tissue, thus arising in an unconventional manner compared to other species. Shoot regeneration is a key step in the process of converting genetic variation produced at the cell level into economic payoffs at the whole plant level.

3. Development of rapid sugarbeet flowering technique which can cut time from planting to flowering from 18 weeks down to 7 weeks for many genotypes. In practice, this controlled environment method is better suited for tissue culture propagules, where inadvertant selection for more easily flowering genotypes in a population is less of a problem.

4. Improved planter improves stand establishment with small quantities of varying size seed. Commercial planters require seed sized rather closely to do a good job of seed spacing. One sugarbeet plant generally produces 3 to 5,000 seeds of varying sizes when processed, which is not enough to be able to plant only one size category. A planter was made which includes a vacuum seed metering device (which can meter varying size seeds), a vacuum clean out, an automated seed dispensing unit, using pre-loaded carousels (eliminates most of the human errors of switching seed planted in pots), and a seed press wheel, which presses the seed into the moist soil with no press wheel pressure on the soil covering the seed (insures more rapid and complete emergence). We had the most uniform stands we've ever had this year with fewer seeds wasted in planting. This planter makes possible more field information from the seed from one plant.

5. The recovery of 15 new "O" type lines from approximately 200 roots in our disease resistance improvement lines represents a gain in the percentage of such recoveries due to intentional prior genetic manipulations. "O" types are the maintainer lines for female lines used in commercial hybrids.

6. Deposition of cultivation soil in and around crowns (hilling) aggrevates Rhizoctonia root rot - In greenhouse studies plants hilled with *Rhizoctonia solani* infested soil had root rot sooner and more severity than unhilled plants. In field plots, hilling significantly increased root rot in susceptible cultivars. In *Rhizoctonia*-free soil, hilling caused no harmful effect.

7. Aerial photography found to aid in evaluating disease damage in sugarbeet plots. - In studies begun in 1974, estimates of damage caused by the principle sugarbeet diseases of the Great Lakes area - *Aphanomyces* black root, *Cercospora* leaf spot, and *Rhizoctonia* crown and root rot - correlated closely with ground-based estimates. Aerial photographs not only provide a rapid means of assessing disease destruction and damage throughout a planting but also provide a visual record of an entire experiment or group of experiments for later evaluation.

8. In the MSU Crop and Soil Sciences Dept. cropping sequence study, crown rot incidence in sugarbeet plots following corn was significantly less than plots following navy beans.

9. Improved methods of applying fungicides were investigated in cooperation with H. S. Potter, Michigan State University. Applications of protectant and systemic fungicides at ½ rate and in 47 l/ha water with new controlled droplet atomizer sprayer controlled *Cercospora* leaf spot and increased sugar yield over untreated control as effectively as applications at full strength in 234 l/ha water with conventional boom sprayer. Application of one systemic and three protectant fungicides by sprinkler irrigation system significantly reduced leaf spot and increased sugar yield over control.

10. New standard fungicides were tested for disease control. Among 19 treatments applied as sprays or granules into crowns *Rhizoctonia* crown rot incidence and severity ranged from 12 to 90 pct. of control with pencycuron rated most outstanding. Among 19 treatments applied as foliar sprays, all significantly reduced *Cercospora* leaf spot, with benomyl and carbendazim rated outstanding. Imazalil fungicide at 56 g/ha have excellent control of powdery mildew and at 20-40 g/100 kg reduced *Phoma betae* seed infection to 0 pct. compared to 22 pct. in control. A MS summarizing 1980-1982 tests of fungicides to control *Rhizoctonia* crown rot was prepared for publication.

11. Biological control of *Aphanomyces cochlioides* black root disease was studied in cooperation with A. Filonow, Michigan State Univ. In greenhouse and field studies with 5 hyperparasites, *Actinoplanes utahensis* (Actinomycete) and *Humicola fuscoatro* (fungus) appeared most promising in reducing disease incidence and severity.

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Hybrid Evaluations

G. J. Hogaboam, J. W. Saunders, and C. L. Schneider

Hybrids evaluated in Experiment 6 were provided by Dr. Richard Hecker as *Rhizoctonia* resistant. The percent *Rhizoctonia* crown rot date were calculated from readings made July 29 & 30, 1982 in our East Lansing disease nursery. The formula used was: [(number dead x 2) + number of plants with symptoms] ÷ total plants in plot.

Hybrids evaluated in Experiment 2 were provided by Dr. G. E. Coe. He also provided the Beltsville leaf spot data. These were not included in the *Rhizoctonia* nursery.

Table of performance of 4 hybrids included in Experiment 6 at the Saginaw Valley Bean and Beet Research Farm in 1982.

Seed No.	Entry	RWSA	T/A	RWST	% Sucrose	% CJP	Rhiz. % Crown Rot	Leaf spot E. Lansing 8-19	8-31
US H20	610	6383	22.3	287	16.80	95.01	72.7	4.0	5.0
791070H11	618	6505	21.6	301	17.51	95.23	42.3	2.7	3.7
791053H8	619	5622	19.4	291	17.01	95.06	58.0	3.3	3.7
791071H2	620	6833	20.9	289	16.86	95.19	68.0	2.0	2.0
Mean (above 4)		6136	21.1	292	17.05	95.12	60.3	3.0	3.5
LSD 5% (4 var. analysis-6 repl)		NS	NS	7	0.34	NS	NS	1.4	NS
CV%		11.22	11.65	1.82	1.61	0.38	25.05	22.9	29.4
Analysis as part of 15 varieties in test									
Mean (15 var.)		5687	21.1	270	16.02	94.47	60.4	2.18	2.75
LSD 5%		1017	4.17	11.3	0.43	0.89	NS	0.88	1.1
CV%		14.12	15.54	3.21	2.17	0.74	31.0	24.3	23.9

Experiment 2. Experimental hybrids from Beltsville at B&B Farm.

Hybrid Parent CMS	O-TYPE	MALE	RWSA	T/A	RWST	% Sucrose	% CJP	Leaf spot Belt. 8-10
6926-01		x 81300-00	6252	22.7	276	16.2	95.01	3.0
80320-01		x 8025-00	4717	17.0	279	16.7	93.83	4.0
80320-02		x "	6593	23.1	285	16.9	94.55	4.0
80566-02		x "	5960	21.4	277	16.5	94.24	4.7
80576-01		x " (A)	6594	21.4	308	17.7	95.97	3.0
79642-01		x " (A)	6214	21.4	289	17.0	94.71	4.3
80645-01		x "	7211	24.9	290	17.0	94.80	3.3
80646-01PK.		x "	6420	20.8	309	17.8	95.61	4.0
81650-01PK.		x "	5848	20.8	281	16.8	94.17	4.7
	US H20		6780	22.8	298	17.2	95.72	5.0
81653-01PK.		x "	6826	23.6	289	17.0	94.69	4.0
79543-01	x 78756-00	x "	6061	20.9	291	17.1	94.92	4.3
79564-01	x "	x "	6573	23.5	280	16.7	94.07	4.3
76682-01	x 67547-0	x "	7041	24.4	289	17.0	94.73	2.7
79620-01	x 78756-00	x "	6424	23.2	277	16.5	94.03	4.3
79624-01	x "	x "	6336	22.1	286	17.0	94.17	3.3
79625-01	x "	x "	5948	21.3	280	16.6	94.48	4.3
79627-01	x "	x "	5953	21.2	279	16.6	94.32	4.3
	US H23		6625	22.5	295	17.1	95.40	3.0

	RWSA	T/A	RWST	% Sucrose	% CJP
Gen Mean	6335	22.0	287	16.9	94.71
LSD (5%)	NS	NS	10	0.4	.66
CV (%)	17.2	17.4	3.1	2.2	0.06

Evaluation of new hybrids for leaf spot resistance. Ratings are the average of 3 plots.

Hybrid			Beltsville			E. Lansing	
CMS	"0"	Male	8-2	8-10	8-20	8-19	8-31
SP7542-01	x SP78564-0	x SP6822-0	4.3	4.6	3.7	3.0	3.7
SP7542-01	x SP78564-0	x EL40	4.0	4.3	5.0	3.3	4.3
SP6926-01	x SP78564-0	x SP6822-0	3.7	4.0	4.3	2.3	3.0
SP6926-01	x SP78564-0	x EL40	3.7	4.0	5.3	2.7	3.7
SP78756-01	x SP78564-0	x SP6822-0	3.7	3.7	4.0	3.7	3.7
SP78756-01	x SP78564-0	x EL40	4.0	4.3	5.0	3.0	3.7
FC506ms	x SP78564-0	x SP6822-0	3.3	3.3	3.3	2.0	2.7
FC506ms	x SP78564-0	x EL40	3.0	3.7	4.0	2.7	3.0
US H23			4.0	4.7	5.7	2.3	3.7
EL36ms	x SP78564-0	x SP6822-0	3.0	3.7	3.3	3.0	3.3
EL36ms	x SP78564-0	x EL40	3.3	4.0	4.3	3.0	3.7
SP75576-01	x SP78564-0	x SP6822-0	3.3	3.3	3.7	3.0	3.3
SP75576-01	x SP78564-0	x EL40	3.0	3.3	4.0	2.7	3.7
SP7542-01	x EL45	x SP6822-0	4.7	5.0	5.0	3.7	5.0
SP7542-01	x EL45	x EL40	4.3	5.0	5.0	4.0	4.7
SP78756-01	x EL45	x SP6822-0	3.7	4.3	5.0	3.0	4.7
SP78756-01	x EL45	x EL40	3.7	4.3	5.3	3.3	4.7
US H20			4.7	5.0	5.0	4.0	5.0
SP75576-01	x EL45	x SP6822-0	3.0	3.7	3.7	3.0	4.0
SP75576-01	x EL45	x EL40	4.0	3.7	4.7	2.7	4.0
SP78641-01	x EL45	x SP6822-0	4.0	4.3	4.3	3.7	3.7
SP78641-01	x EL45	x EL40	4.0	5.0	5.0	3.3	3.7
SP78745-01	x EL45	x SP6822-0	4.3	5.3	5.3	3.3	4.3
SP78745-01	x EL45	x EL40	4.3	5.0	6.0	3.7	4.3

Evaluation of Commercial and semi-commercial types. Ratings are the average of 3 plots.

Seed Source	Variety	Beltsville 8-2	Beltsville 8-10	Beltsville 8-20	E. Lansing 8-19	E. Lansing 8-31
Am. Crys.	ACH154	3.3	4.6	4.9	3.0	3.7
GW	Mono-Hy E4	2.9	3.8	4.5	2.7	3.7
Beta	Beta 512 (OCO 180)	3.5	4.4	5.0	3.3	4.0
F&M	US H20A	4.3	5.3	6.0	4.0	4.7
Holly	HH33	3.5	4.8	4.8	2.7	3.3
F&M	US H23	4.0	4.9	5.2	2.7	3.7
Beta	Beta 522 (OCO 179)	3.3	3.8	4.5	3.0	3.3
GW	Mono-Hy E7	3.3	4.0	4.7	2.7	3.0
Holly	0459-03	3.3	4.3	5.0	2.3	3.0
GW	79MSC154	3.3	3.7	4.3	2.3	2.7
Am. Crys.	C78-25	3.3	4.3	5.0	2.3	2.3
F&M	F&M H12	3.7	4.3	5.0	3.7	3.7
F&M	US H20 (checks)	4.3	5.0	6.0	3.7	4.0
Holly	04114-03	3.3	3.7	4.3	2.7	3.0
F&M	US H23 (check)	3.7	4.3	5.3	2.7	3.0
AM. Crys.	ACH167	3.3	4.3	5.0	3.0	3.7
Holly	0452-02 (14308-034)	3.7	4.0	5.0	2.0	2.7
GW	81MSC115	3.7	4.3	5.0	2.7	3.7
Hilleshog	Mono 5416	4.0	4.0	5.0	2.3	3.0
Hilleshog	Mono 5419	3.3	4.0	5.0	2.3	3.3
Hilleshog	Mono 4086	3.3	3.7	4.3	2.7	3.3
F&M	Mono-Hy E4 (check)	3.3	4.0	5.0	2.3	3.3
F&M	F&M H13	2.7	3.0	3.7	2.3	2.3

Present Application of Shoot Culture in East Lansing Breeding Program

J. W. Saunders

In vitro sugarbeet shoot cultures are used to retain unique self-sterile gene combinations intact (J. W. Saunders. Crop Sci. 22:1102-1105. 1982). Breeding material, both monogerm and multigerm, is cloned from flowering plants in both greenhouse and field, and reverts to the vegetative state *in vitro*.

The best time to collect 1 cm long lateral buds in the field is as the plant is bolting, but just before flower opening. At this stage the buds are unfolding in rapid growth and there is minimal time for wind blown spores and bacteria to lodge on the bud. Buds somewhat below the top of the plant and near, if not on the main axis are preferred, because the nodes will have incompletely reproductive buds. Once the shoot culture is established, it is kept at 5 C until late winter. Clones for which the mother beet did not produce enough seed or for which the seed failed a seed or seedling test are culled as the data becomes available. Rooted shoots are set out in a nursery in the late spring and those ramets (copies) of the superior combiners are brought in in November after progeny evaluation, whence they are used in a further interpollination.

Genotypes cloned from greenhouse polycross locations in the winter are only kept as shoot cultures for three months until their rooted shoots can be set out in the ramet nursery in late spring. Any leftover shoots in culture are kept at 5 C for possible use later if they are still alive. One ramet of each genotype is put into 5 C in early June for vernalization. Monogerm genotypes test-crossed in search of O-types can tentatively be classified by late summer, whence the vernalized ramets can be used for re-initiation of shoot cultures of the tentative O-types.

In order to minimize culture transfer load, only O-types and elite genotypes (i.e., those for which a future need is expected) are continuously kept as shoot cultures. All greenhouse seed producers are cloned by shoot culture, and more than a third of field seed producers. As the number of O-types in stock and uses of them increases, available resources will limit the number of genotypes that will be cloned from the field.

One consideration in dealing with clones as part of a population improvement program is that inadvertant narrowing of the germplasm base will be more likely within the constraints of fixed resources than if half-sib progeny are used to hold favorable gene combinations.

Tests of Fungicides to Control *Cercospora* Leaf Spot and *Rhizoctonia* Crown Rot Diseases of Sugarbeet

C. L. Schneider

1. Cercospora leaf spot - plots of commercial sugarbeet variety US H20, each comprising two 7-m rows, were planted on 6 May at the Michigan Muck Farm Experiment Station near Bath, MI. Dried and ground sugarbeet leaf inoculum of *Cercospora beticola* was applied on the foliage on 23 June. Plots were sprinkler-irrigated thereafter throughout the season to maintain high humidity. Commencing 21 July, fungicide treatments were applied four times at 14-day intervals with a hand-operated, CO_2-powered sprayer at 103.4 kPa pressure and at the rate of 561 liters spray material/ha (60 gal/a). The treatments included seven tank mixes and two alternating applications of two different materials. Between each plot was an untreated buffer row.

   Plots were rated according to degree of disease severity on 31 August. All treatments reduced disease severity significantly below that of the untreated control. There were significant differences among treatments with disease ratings ranging from 22.4 to 83.6% of that of the control (Table 1). Superior treatments included benomyl, carbendazim + maneb, and TBZ + fentin hydroxide. TBZ + fentin hydroxide mixture provided better control than alternate applications of same chemicals at 14-day intervals.

   In this experiment, it was also shown that differences in leaf spot disease severity among plots can be readily determined by aerial photography. The experimental area was included in an infrared color aerial photograph on a 70-mm transparency at a scale of 1:5129, obtained in mid-September, 1982. The transparency was viewed in a microfiche reader at X32. Relative degree of foliage production estimated from each plot image was expressed numerically according to an index from 1 (none) to 10 (luxuriant).

   There were significant differences among treatment photo ratings (Table 1). The correlation between leaf spot severity ratings and photo ratings was highly significant (P=0.01). In plot by plot comparison, r= -.77 (71 d.f.) and in treatment by treatment comparison, r=-.89 (17 d.f.).

2. Rhizoctonia crown rot - plots of commercial sugarbeet variety US H20, each comprising one 7-m row spaced at 71.1 cm, were planted on 13 May 1982 in a field of Conover loam soil on the Michigan Agricultural Experiment Station at East Lansing. Dried millet grain inoculum of *Rhizoctonia solani* was applied along the rows and into the crowns on 8 July at the rate of 33 cc/m of row. Plants were then hilled-up with cultivation soil. Fungicides were applied as aqueous sprays in a 20-cm band along the rows and into the crowns with a hand-operated CO_2-powered sprayer at 103.4 kPa pressure and at 60 gal spray material/acre (561 liters/ha), or as granules, on 30 June and 20 July. Disease incidence and severity, expressed as percent, were estimated according to above ground symptoms on 23 July. Each plant was graded according to an index (0=no symptoms; 1=crown rot symptoms; 2=dead). Percent crown rot for each plot was computed according to the formula: % crown rot = Σ (no. plants in each disease severity class x class value) x 100 $\div$ no. plants inoculated x 2 (highest value). Percent crown rot was similarly determined from harvested roots on 10 Sept. with an expanded disease index ranging from 0 (no symptoms) to 4 (dead). Disease severity progressively increased up to time of harvest, when percent crown rot in untreated control plots averaged 89.3% and ranged from 11.6 to 71.3% among treatments that were significantly below the control (Table 2). Experimental fungicide NTN 19701 (proposed name=pencycuron), supplied by Mobay Chemical Corp., provided superior control.

Table 1. Test of fungicides to control leafspot disease in plots inoculated with <u>Cercospora beticola</u> at the Michigan Muck Farm Experiment Station, 1982.

Treatment No.	Fungicide and rate (active) kg/ha[1]	Disease Index[2,4]	Photo Rating[3,4]
1	Benomyl, 0.28	2.0 BC	7.5 AB
2	Benomyl, 0.42	1.4 A	7.4 ABC
3	Benomyl + maneb, 0.21 + 0.90 (mix)	1.6 AB	7.8 AB
4	Carbendazim + maneb, 0.14 + 0.90 (mix)	2.1 C	7.0 BCD
5	Carbendazim + maneb, 0.28 + 0.90 (mix)	1.3 A	8.3 A
6	Imazalil, 0.11	4.1 FG	5.8 EFG
7	Imazalil, 0.17	4.4 G	4.9 GH
8	Imazalil, 0.28	3.8 F	5.1 FGH
9	TBZ, 0.42	3.0 DE	7.3 ABC
10	TBZ + maneb, 0.42 + 1.00 (mix)	2.1 C	7.0 BCD
11	TBZ + maneb, 0.21 + 0.50 (mix)	3.1 DE	6.4 CDE
12	TBZ + TPTH, 0.42 + 0.35 (mix)	2.0 BC	7.5 ABC
13	TBZ + TPTH, 0.21 + 0.175 (mix)	2.0 BC	7.1 BCD
14	Maneb, 1.00	3.3 E	5.6 EFG
15	TPTH, 0.35	2.8 D	7.8 AB
16	TBZ + maneb, 0.42 + 1.00 (Alternate)	2.9 DE	6.1 EFG
17	TBZ + TPTH, 0.42 + 0.35 (Alternate)	2.8 D	7.3 ABC
18	Control untreated	4.9 H	4.5 H

[1] Four applications at 14-day intervals, commencing 21 July.

[2] Disease index = 0 (no symptoms) - 9 (complete defoliation).

[3] Photo rating index = 1 (no foliage) - 10 (luxuriant foliage).

[4] Means of four 2-row plots, 7-m long. Treatments followed by same letter do not differ significantly ($p = 0.05$) according to the FLSD test.

Table 2. Test of fungicides to control *Rhizoctonia* crown rot of sugarbeet - East Lansing, MI, Experiment Station - 1982.

Treatment No.	Fungicide and rate of product/acre (ha)[1]	Percent Crown Rot[2]	
		23 July	10 September
1	NTN 19701 25W 4.0 lb (4.48 kg)	1.1 A	28.0 B
2	NTN 19701 25W 8.0 lb (8.96 kg)	1.3 A	11.6 A
3	Terraclor 2EC, 1.5 gal (14.03 liters)	54.3 DE	76.0 GHI
4	Terraclor 2EC, 2.0 gal (18.70 liters)	59.3 DE	81.8 HI
5	Bayleton 25W, 8.0 oz (560 g)	11.4 BC	51.5 D
6	Bayleton 25W, 1.0 lb (1.12 kg)	2.2 AB	34.7 BC
7	Benlate 50W, 8.0 oz (560 g)	67.3 DE	79.0 HI
8	Benlate 50W, 12.0 oz (841 g)	68.3 DE	81.1 HI
9	Bravo 500F, 36.0 fl oz (2.63 liters)	24.7 C	60.2 DEF
10	Bravo 500F, 72.0 fl oz (5.26 liters)	20.7 C	62.2 DEFG
11	Rovral 50W, 8.0 oz (560 g)	47.7 D	70.7 EFGH
12	Rovral 50W, 1.0 lb (1.12 kg)	57.6 DE	73.5 FGH
13	Super Tin 4L, 9.6 fl oz (701 ml)	20.7 C	49.7 C
14	Super Tin 4L, 19.2 fl oz (1.40 liters)	21.4 C	56.3 DE
15	Terraclor 2EC, 0.5 gal (4.68 liters)	73.7 E	86.7 HI
16	Terraclor 2EC, 1.0 gal (9.35 liters)	52.2 DE	70.8 EFGH
17	Bayleton 5G, 1.25 lb (1.40 kg)	40.6 D	75.9 GHI
18	Bayleton 5G, 2.5 lb (2.80 kg)	65.3 DE	78.9 HI
19	Bayleton 5G, 3.75 lb (4.20 kg)	49.7 D	71.3 EFGH
20	Control, untreated	69.1 DE	89.3 I
	CV (%)	29.9	18.8

[1] Applied on 20/6 and 20/7

[2] Means of 5 single-row plots, 7-m long. Treatments followed by the same letter do not differ significantly at the 5% level according to the FLSD test.

BREEDING SUGARBEETS FOR RESISTANCE TO BLACK ROOT AND LEAF SPOT

G. E. Coe

Research work on sugarbeets at the Agricultural Research Center, Beltsville, Maryland is directed toward varietal improvement of sugarbeets resistant to Aphanomyces black root and Cereospora leaf spot, important diseases in eastern United States. Considerable effort is now directed toward the production of "soil-free" taproots to eliminate mechanical cleaning. In addition, two other types of breeding lines are being produced: 1) a line with resistance to southern root rot (Sclerotium rolfsii); and 2) a line with low content of nonsucrose solubles.

Testing for Leaf Spot Resistance

There was a good leaf spot epidemic in the early Beltsville planting. Our most resistant breeding lines exhibited a marked increase in resistance over previous generations. An increase in resistance of this magnitude is noticed about every 3rd or 4th cycle of selection, but was somewhat unexpected this year because selection for the last several years have emphasized yield, sucrose percentage, and purity rather than leaf spot resistance. Results of the leaf spot nursery tests are presented in Table 1.

As expected, the leaf spot epidemic was not as severe in our late planting as in our early planting making comparisons between the two questionable. In both plantings, however, our resistant check variety was more resistant than the average of our breeding lines, and the average of the breeding lines was much more resistant than USH20. The progenies reported on lines 4 and 5 in Table 1 indicate that our "soil-free" lines have less resistance than our most advanced lines but considerably more resistance than USH20. Two of the breeding lines on line 1 and 2 are multigerm progenies with a rating of 1.3 (this approaches apparent immunity in our test); 3 of the multigerm progenies had a rating of 1.7; and 15 of them had a rating of 2.0. In the third line in the table, 5 of the monogerm progenies had a rating of 1.7 and 6 had a rating of 2.0. Eighty-two multigerm roots selected from progenies with a leaf spot rating of 2.0 or less averaged 3.2 lbs., 15.0% sucrose, and 2.40% nonsucrose solubles (NSS). One hundred fifty-seven multigerm roots selected from progenies with leaf spot ratings from 2.3 to 3.0 averaged 3.1 lbs, 14.6% sucrose, and 2.47% nonsucrose solubles. I conclude that even within this narrow range of leaf spot rating (from good to excellent resistance) a numerical rating increase of 1, (i.e. a decrease in resistance) decreases sugar percentage about 1/2 a percentage point (2.7% decline), and increases the percent of NSS about .07% (2.9% increase).

The effect of leaf spot on sucrose (and probably on nonsucrose solubles also) would undoubtedly be greater when comparing plants taken from progenies with disease ratings of 2.3 to 3.0 with plants taken from progenies with disease ratings from 3.3 to 4.0. Unfortunately, we had only 3 out of 68 progenies with disease ratings higher than 3, and no roots were selected from them. The effect of leaf spot on root weights in these data isn't meaningful since all roots were selected roots.

TABLE 1. Results of leaf spot tests at Beltsville in 1982.

Description	No. lines Tested	Av. Leaf Spot Rating* Breeding Lines	USH20 Check	Resistant Check
a. Early Planting				
Beltsville MM BRR-LSR lines from BRR selections	56	2.5	5.0	2.2
Beltsville MM BRR-LSR lines from LSR selections	12	2.4	5.0	2.2
Beltsville mm lines	52	2.5	5.0	2.4
Cold Temperature MM selections	68	3.1	5.0	2.3
"Soil-free" MM from 1981 greenhouse	68	3.2	5.0	2.5
F_2 of "Soil-free" MM X best MM selections	34	3.3	5.0	2.0
b. Late Planting				
"Soil-free" MM from 1982 greenhouse	68	2.9	4.9	1.7
mm from East Lansing	97	2.6	4.5	1.9

* 0 = No spots; 10 = All leaves dead.

A rough measure of the rate of progress in increasing leaf spot resistance can be made by comparing the cold temperature germination selections in Table 1 with the multigerm BRR-LSR material. The former has 3 fewer cycles of selection than the latter, and .6 of a rating point less resistance. If that rate of increasing resistance could be maintained, the majority of the breeding lines should reach a rating of 1 (near immunity) after 7 more cycles of selection (14 years).

Testing for Black Root Resistance

The results of testing the Beltsville Sugarbeet breeding lines for black root resistance are presented in Table 2.

TABLE 2. Results of Testing of 1981 Seed Productions for BRR.

Description	No. Lines Tested	Av. Black Root Rating*		
		Tested Lines	Resistant Check	Susceptible Check
MM progenies from leaf spot selections	66	105	100	105
MM progenies from black root selections	183	101	100	107
E-Type MM from leaf spot selections	25	101	100	108
MM progenies from cold temperature germination selections	64	111	100	107
mm progenies from leaf spot selections	224	104	100	106

* 115 = death of all seedlings; 65 = no infection

The multigerm progenies on lines 1,2, and 3 of Table 2 have had 3 more cycles of selection for black root resistance than the multigerm progenies on line 4. The difference in the average black root rating of 6 to 10 rating points represents a great deal of difference in resistance. Each year we have more progenies with ratings in the 80's and the minimum disease rating (indicating the best resistance) continues to decline slowly. One obvious problem has developed, however. Note that the progenies coming from a preceding black root selection have better resistance (lower disease ratings) than progenies coming from a preceding leaf spot selection. A check of results from previous years reveals this to be the case every year. Black root selections are made in alternate generations with leaf spot selections. A check of the results of leaf spot testing (Table 1 of this report and a check of data from previous years) reveals that progenies coming from a preceding leaf spot selection have more resistance to leaf spot than progenies coming from black root selections. This indicates that either some of the genetic factors conditioning leaf spot resistance also condition the plants for a measure of black root susceptibility or visa-versa. In spite of this difficulty, progress (although perhaps somewhat slow) is being made in improving resistance to both diseases.

Selecting for Resistance to Southern Root Rot

A second cycle of selection for southern root rot, Sclerotium rolfsii, was made in 1981 among 9 progenies of SP7822-0 together with more selections from SP7822-0. The number of selected plants from each breeding line is listed in Table 3.

TABLE 3. Test results of progenies produced from plants selected for resistance to southern root rot.

Parent Line	No. of selected plants Producing Seed	No. of progenies apparently having: more resistance	equal resistance	less resistance
7822-0	17	12	5	0
8122-1	13	4	9	0
8122-2	10	2	2	6
8122-4	6	2	2	2
8122-5	17	9	1	7
8122-6	6	6	0	0
8122-7	2	0	2	0
8122-10	2	2	0	0
8122-11	5	4	1	0
8122-12	3	3	0	0
8122-13	11*	-	-	-

* In tests now. No results at this time.

Of the 81 progenies tested, 44 appeared to be more resistant than the original parent, 22 appeared to have the same level of resistance, and 15 appeared to be less resistant. The progenies with less resistance were descendants of only 3 of the parental lines. Thus, it would appear that selecting in certain parental lines is more effective than selecting in other parental lines. On the other hand, it is possible that we weren't as critical in selecting plants from some tests. For example, the selected plants from SP7822-0 were taken from the check plants in all the progeny tests and hence came from about 5 times as many plants as any of the other lines tested. Thus, our selection from SP7822-0 was more critical than our other selections resulting in a high percentage of resistant progenies. All the progenies from three of the other parental lines, however, appeared to be more resistant than SP7822-0.

With regard to hypocotyl diameter at the time of inoculation, the larger the hypocotyl the greater physical advantage the plant has of resisting the fungus. One would think that selecting resistant plants with average or slightly smaller-than-average hypocotyl size would be a selection for true resistance. Such is not the case. Selected plants with large hypocotyls yielded progenies with as much resistance as plants with average or smaller-than-average hypocotyls. Interestingly enough, in about 95% of the progenies the hypocotyl diameters drifted back toward an average hypocotyl size, so that progenies coming from selections with large hypocotyls had no

larger hypocotyls than progenies coming from selections with average or smaller-than-average hypocotyls. In making selections, however, it is important that plants with large hypocotyls appear outstanding when the selection is made. Like most selection procedures this technique leaves a great deal to be desired, but it is effective and progress is being made.

Selecting for Low Content of Nonsucrose Solubles

Previous work has shown that the content of nonsucrose solubles (NSS) is affected by location in the nursery plot. Every experiment appears to be a mosaic of areas where beets are either all high or all low in content of NSS. To compensate for this we attempted a selection plot experiment with paired plants (8 inches apart) in hills 2 ft. apart. Unfortunately, there was a great difference in the size of the pair of plants in most hills. Root size has an effect on the content of NSS as will be indicated in data presented in a subsequent paragraph. Hence, selecting the better of 2 paired plants in a hill in this test will probably not be very effective. One of the outside rows in this test was next to a row with extremely poor emergence. The paired plants in the hills in this outside row were larger and more nearly equal in size. Selection plots in 1983 will be planted in wide (4') rows to overcome in part the difficulty of paired plants of unequal size.

The analysis of individual roots reported in the leaf spot testing portion of this report indicated the effect of even a minor difference of leaf spot infection on percent sucrose and nonsucrose solubles. In addition root weight influences percent sucrose and percent NSS. The same data used to indicate the effect of leaf spot are presented in Table 4 to show the effect of root weight.

TABLE 4. The effect of the weight of selected roots on % sucrose and % nonsucrose solids.

Root Weight Class	No. Roots Analyzed	Av. % Sucrose	Av. % NSS
1.1 to 2.0 lbs.	21	15.42	2.31
2.1 to 3.0 lbs.	99	15.17	2.47
3.1 to 4.0 lbs.	82	14.57	2.48
4.1 to 5.0 lbs.	29	13.57	2.54
5.1 to 6.0 lbs.	8	13.34	2.44

The conclusions drawn from the data in Table 4 assumes that differences in leaf spot ratings among individual plants is distributed approximately equally across the weight size classes. These data indicate that 12% of the difference in sucrose percentage between a 1 1/2 lb. root and a 4 1/2 lb. root (1.85 sugar percentage points) is attributable to the difference

in the size of the roots. This inverse relationship has long been known. In a similar manner, 9.1% of the difference (increase) in the content of NSS is a result of the 3 lb. difference in root size. This must be taken into account when selecting for improvement in these characteristics. (The relationship between root size and percent of NSS has been confirmed by other experiments we have conducted.) The low average for content of NSS in roots weighing more than 5.1 lb. might be a random variation since only 8 roots contributed to this datum, but perhaps roots this large simply have so much growing vigor that they utilize NSS solubles more efficiently than smaller roots.

In the 1981 Research Report (page E15) we indicated that percent sucrose and percent NSS generally move up and down together. The data from 1982 experiments do not confirm this, but suggest that when % sucrose is high, the % of NSS tends to be lower. This, however could simply be a reflection of the effect of leaf spot on these two constituents. Experiments designed specifically to answer this question should be conducted.

Development of Soil-Free Sugarbeet Taproots

Running experiments at Beltsville to show how much less soil adheres to our "soil-free" breeding lines as compared to the commercial hybrid, USH20, would probably indicate in most years that they have only 1/4 or less as much adhering soil. Such experiments would be of little value other than to measure roughly, perhaps, the rate of progress being made. Consequently, we don't run this type of experiment at this stage of development, but instead our efforts have concentrated on selecting the very cleanest types from large numbers of roots among many progenies, while concurrently testing to maintain or improve yield, sucrose percentage, purity, and leaf spot resistance. Since all components of a hybrid must have the genetic factors conditioning the soil-free characteristic and since many genetic factors are obviously involved, we have included in our program the production of a soil-free monogerm O-type. In 1982 we selected from our nursery the best "soil-free" monogerm plants in the F_3 generation of a cross of a monogerm O-type to the best 'soil-free' multigerm lines we had three years ago. These selections were better in freedom from soil than I expected. They will be placed in a separate isolation for crossing to cytoplasmic male-sterile lines to index for and recover O-type pollinator plants.

Cold Temperature Germination Selections

Considerable difference among individual plant progenies in speed of germination occurs in our cold temperature germination tests. Three cycles of selection have been made attempting to increase the speed of germination by selecting the earliest emerging seedlings from the fastest germinating progenies, but I still haven't proven to my satisfaction that a heritable increase in germination speed has been achieved. Most of our tests have compared 2 1/2 year old parent seed with 1/2 year old progeny seed. Sugarbeet seed stored under Beltsville conditions for 2 years loses viability and probably results in delayed initiation of organic chemical action: Seed increase of the parent line should be made at the same time as the seed increase of the selected plant. In the 2 cases where seed increases of this type have been made, the progeny emerged no quicker than

the parent line. (See the first two items in Table 5). The quick germination of certain progenies might be explained on the basis of a healthy parent plant in a favored environment producing robust seed containing few inhibiting chemicals as compared with another plant in a localized soil condition that favored the accumulation of germination inhibiting chemicals or a lack of some substance that results in less than maximum seed development. Results of our 1982 cold temperature germination tests are presented in Table 5.

The cold frame test in Table 5 was planted March 1, 1982. Temperatures were relatively cold with morning soil temperatures at 1 inch depth remaining below +4°C until March 12. On March 12 and 13 the temperature rose to 7°C but then dropped below 5°C the rest of the test period. Afternoon soil temperatures at the 1 inch depth were below 5°C until March 8, and then varied radically from 9°C to 20°C during the rest of the testing period. Note that there is only a 2 day difference in time required for emergence between the fastest emerging and the slowest emerging progenies. In the cold room tests run at 13°C on the same progenies there was a 4 day difference between the most rapid emerging lines and the average of all other lines run at that temperature. The same was true for tests run at 7°C. This year we are comparing progenies selected for rapid emergence at cold temperatures with other breeding material of the same ancestry that has had no selection for ability to germinate at cold temperature.

Monogerm O-types

We have depended on selfed seed to maintain a monogerm pollinator plant while progeny from its male-sterile cross is being indexed in the greenhouse. Because of a high degree of self-incompatibility in the pollinator plants in our 1981 crossing plot (to produce progenies for indexing), we had only 26 progenies for indexing. Of these 3 appear to be O-types. They must be indexed again after the first seed increase to confirm the results of the first indexing test. Four apparent new O-types from a previous years test were confirmed this year.

TABLE 5. Cold Temperature Germination Tests at Beltsville in 1982.

		Cold Frame Test		Cold Room Test		
Seed Number Germination	Parent or Progeny	Days to Emergence	% Germination at 23 days	Temp. ^{0}C	Days to Emergence	%
81362-0	Parent	19	85			
81365-0	Progeny	20	60			
81363-0	Parent	19 1/2	75			
81364-0	Progeny	19 1/2	60			
79309-6	Parent	19	45	-	-	-
81360-38	Progeny	17 1/2	95	13	8	100
79309-39	Parent	19	35	-	-	-
81360-52	Progeny	17	75	13	6	66
79309-8	Parent	20	20	-	-	-
81361-5	Progeny	19	85	7	12	80
81360-54	Progeny	17	75	13	6	96
81360-95	Progeny	18	85	7	13	80
79309-16	Parent	19	80	-	-	-
81360-56	Progeny	17	90	13	7	98
81360-160	Progeny	17	80	7	10	80
79309-59	Parent	19	25	-	-	-
81360-161	Progeny	17 1/2	85	7	13	60
79309-21	Parent	19	75	-	-	-
81360-163	Progeny	18 1/2	55	7	12	65
79309-53	Parent	19	85	-	-	-
81361-4	Progeny	18 1/2	85	7	13	80
Average of All Others	Progenies			13	10	85
Average of All Others	Progenies			7	14	70